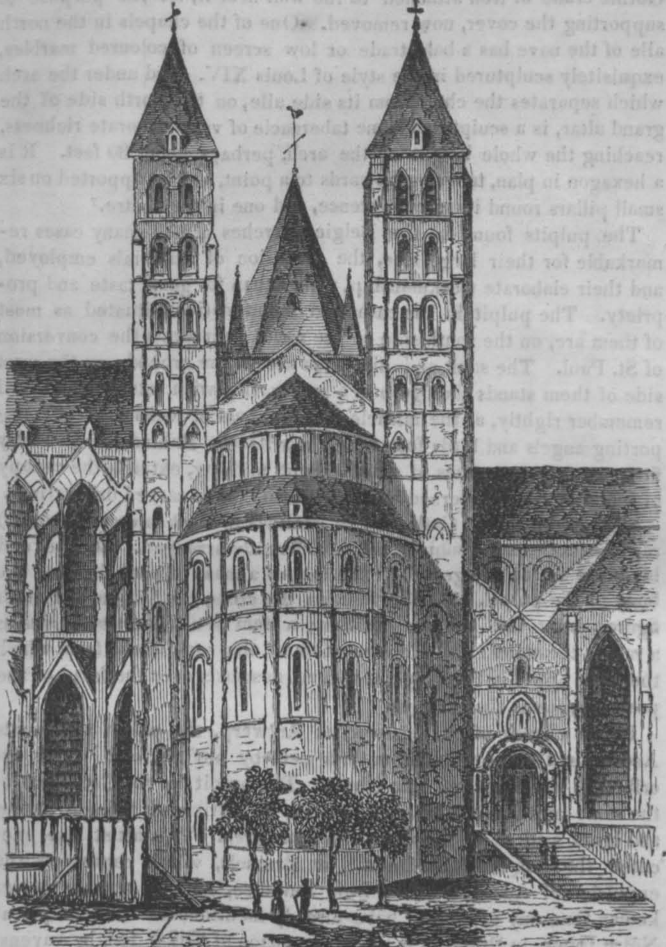
BUILDINGS IN BELGIUM.

By George Godwin, Jun., F.R.S., &c.

"Perhaps no study reveals to us more forcibly the social condition and true feeling of passed generations than that of their monuments."—M. Guizot.

Chapter II.



Concerning the age of the Cathedral, there has been some controversy. Monsieur B. C. Dumortier, a member of the Belgic Chamber of Representatives and of the Royal Academy of Brussels, (and in company with whom the writer had the good fortune to examine the building) published first in 1837,[1] some remarks on the Cathedral, and then in 1841, a second pamphlet,[2] with a view to prove that the nave of the existing building belonged to the 6th century. These essays display much learning and ingenuity, but more enthusiasm, and this latter has served to blind the writer to all that militated against his desire to obtain unlimited reverence for his favourite building, and like an unruly Pegasus, has carried him far away from the goal he sought, namely the truth. Absence of direct statement by early writers that the nave was destroyed, serves to prove to M. Dumortier, (as in some similar cases it has been urged by other continental antiquaries) that it has not been rebuilt, and so far from the fact that pointed arches form an essential feature in it being deemed sufficient to weaken his opinion, it is proof strong as holy writ that the system of pointed architecture arose in Belgium, and that in the cathedral of Tournay is to be found its first out-budding. In confirmation of his opinion, M. Dumortier informed me, that a charter had been recently discovered dated 1257, proving that the architect of Cologne Cathedral was a Belgian. It sets forth that the monks of Cologne, in consideration of the services performed by Master Gerard, of St. Trond (*Gerardus de Sancto Trudone*), in directing the construction of their Cathedral, had assigned to him a certain estate of land.

Although apart from the present purpose, I cannot avoid repeating here a portion of the King of Prussia's speech when laying the first stone of the new works in completion of the last mentioned wonderful building. "Here where the ground stone lies," said the king, "here by these towers, will arise the noblest portal in the world. Germany builds it—may it be for her, with God's will, the portal of a new era, great and good. Far from her be all wickedness, all iniquity, and all that is ungenuine and therefore un-German. May dis-union between the German princes and their people, between different faiths and different classes, never find this road; and never may that feeling appear here, which, in former times stopped the progress of this temple—aye, even stopped the advance of our Fatherland. Men of Cologne, the possession of this building is a high privilege for your city, enjoyed by none other, and nobly this day have you acknowledged that it is so. Shout, then, with me, and while you shout will I strike the ground-stone,—shout loudly with me your rallying cry, ten centuries old, "Cologne for ever!" And then, while a thousand voices re-echoed "Cologne for ever!" the ancient crane on the top of the south tower was once again put into motion, and was seen slowly raising a ponderous stone. The amount both of time and money required to complete the Cathedral renders the issue somewhat doubtful. Let us hope, however, that this fear may be unfounded, and that this magnificent building may gradually gain its intended proportions—an emblem of unity, a worthy offering to God, and an ornament to the world.

To return, however, to Tournay; there is sufficient evidence to induce the belief that the Cathedral was founded at the end of the 3rd century, and rebuilt about the middle of the 5th century, with the aid of Clovis, by St. Eleutherius. Chilpéric in 578, endowed the Cathedral largely, and his original deed of gift "*cum sigillis*," remained amongst the archives of the chapter until they were burnt in 1566.[3] Louis le-débonnaire added to the cloisters of the Cathedral in 817, and Charles the Simple further endowed it. Soon after this, however, namely in 882, the Normans ravaged Belgium with fire and sword, and inspired such universal dread, that the people, adding to their prayers "from the fury of the North-men, Good Lord deliver us," fled in all directions. Tournay, rich and important as it then was, did not escape; the walls and the chief buildings were destroyed, and the inhabitants were forced to abandon the town, to which it seems they did not return until the beginning of the 10th century. At the time of this invasion there can be little doubt the Cathedral was pillaged, and partly if not wholly demolished; and it is probable that its re-erection was not attempted until quite the close of the 10th century, in which the inhabitants returned, or rather the beginning of the 11th. All analogy shows that earlier than this, the nave and transepts could hardly have been commenced, and that it was probably much later before they were completed.[4] If analogy, however, were deemed insufficient to remove

[1] "*Revue de Bruxelles*," Dec. 1837.

[2] "*Dissertation sur l'age de la Cathédrale de Tournai.*" *Bruxelles*, 1841.

[3] The deeds must have been very numerous, if we believe a contemporary writer, who says that the melted wax from the seals formed a stream down the hill.

[4] It is but fair towards M. Dumortier to give, in his own words, his argument against the assumed destruction of the Cathedral by the Normans:—

"L'histoire de la translation du corps de Saint Eleuthère sous l'évêque Hédilion en 876, immédiatement avant l'invasion des Normands, nous fait connaître qu'â cette époque l'on avait démoli la chapelle de Saint Etienne, qui était située à la suite de la cathédrale. Voici comment s'exprime la chronique écrite au XIe siècle: *Presulatum tornacensis ecclesiæ Heidelone viro prudenti et justo possidente, basilica beati Stephani prothomartyris, quæ sita est post ecclesiam Christi genitricis semperque virginis Mariæ, destructa est.**

Le soin que prend le chroniqueur à nous apprendre la destruction de la chapelle de Saint Etienne annexée (?) a la Cathedrale, indique clairment la conservation de celle-ci. Si ce vaste monument, dont l'existence est démontrée et au VIe et au IXe siècle, avait été détruit lors de l'invasion des Normands, le chroniqueur se serait-il borné à nous apprendre la destruction d'une de ses parties? C'est ici que s'applique se vieil adage; *inclusio unius, ex-*

* *Elevatio corporis beati Eleutherii tornacensis episcopi et confessoris; MS. in Libro Sancti Martini Tornacensis.*

the ground for controversy respecting the age of the cathedral, it would seem to be destroyed by the recent discovery of a M. S. entitled "*Ritus Officii divini ecclesiæ Tornac,*" and dated 1656. This gives a list of the various fêtes formerly celebrated in the Cathedral, and points out the 9th of May (which was then annually celebrated), as the anniversary of the dedication of the church, in the following words: "*Dedicatio ecclesiæ, est festivus dies in populo intrà muros. Triplex est cum octavâ et duplex primæ classis;*" and then, "*Videliscet novæ, anno* 1066." Monsieur T. Le Maistre d'Anstaing, who mentions this MS. in his very interesting work on the Cathedral,[5] remarks that doubtless there were more consecrations than one, as for example that of the choir, and those after partial restorations; but that this being the first, was properly regarded as the most important, and, being duly observed, had been handed down to the date of the MS. alluded to.

In a comparatively short space of time after this date, if the historian Jean Cousin is to be believed,[6] the choir becoming too small and probably being injured by the events of troublous times, was cleared away to make room for a more magnificent structure. Cousin states, that the first stone of the new choir was laid in 1110; and that it was finished about 80 years afterwards or more. His authority for this statement, however, does not appear. According to certain old chroniclers quoted by M. d'Anstaing, it was vaulted in 1242, at the expense of Walter de Marvis; but it would seem that divine service had been performed in it previous to that date, its dedication being ascribed to the year 1200.

At the end of the twelfth century, pointed architecture was but just developing itself, so that we must conclude either that the choir of the Cathedral of Tournay is one of the earliest monuments of that style, or that the received statements are erroneous. I am inclined to believe the former.

In concluding these remarks on the Cathedral of Tournay, it is gratifying to be able to say, that the sum of £20,000 has been voted by the nation (to be expended in ten years) for the restoration of this noble building, and that under the direction of M. Renard, the architect, there is every reason to expect it will be carried out efficiently.

When speaking of the Town Hall at Louvain, the writer intended mentioning, that what is stated to be the original drawing of the west front of the Cathedral of that town is preserved there, together with a very elaborate and beautifully executed model of the same in stone as it was executed, with a singularly lofty tower and spire in the centre, and another on either side of it; only one of the side towers, however, is shown. The drawing is on vellum, 9 ft. high and 2 feet 9 inches wide, and is coarsely but carefully executed. The model is about 24 feet high and 7 feet 6 inches wide at the base, and is now in an excellent state of repair. The centre spire, which is said to have been above 500 feet high (an extraordinary elevation, exceeding, by 100 feet, that of the spire of Salisbury Cathedral) was destroyed in 1606 by a storm, and in its fall ruined the side towers.

clusio alterius. Ainsi il demeure démontré que la Cathédrale de Tournai ne fut pas detruite à cette époque, et qu'elle resista á l'invasion Normande. En effet, celui qui a vu ce noble édifice, et considéré l'épaisseur des colonnes de sa partie romane, la solidité des matériaux employés a sa construction, n'hésitera pas à reconnaître qu'avec de tels matériaux il existait des conditions de durée que l'on ne retrouve pas dans les églises des provinces Rhénanes, et qu'ainsi s'explique pourquoi Nôtre Dame de Tournai a pu résister à une époque où tant d'autres édifices religieux ont succombé. Au lieu d'être construite comme les églises des bords du Rhin en un calcaire sablonneux, friable et de peu de durée, la basilique de Tournai est construite en calcaire anthraxifère, espèce de marbre tres dur, et faisant feu sous le briquet. Pour détruite un édifice aussi gigantesque, et composé de pierres aussi solides et aussi massives, il faudrait de milliers d'ouvriers et un travail de plusieurs années. Or, les Normands avaient toute autre chose à faire que de passer leur temps à un tel ouvrage. Aussi, tous les chroniqueurs et les historiens de Tournai ont parlé de la Cathédrale, et l'on ne trouve, dans leurs écrits, aucune indication d'où l'on pourrait induire que ce vaste monument aurait été détruit et reconstruit à la suite de l'epoque carlovingienne. Au contraire, preuve certaine que l'édifice etait dejà bien vieux à cette epoque. il est constant que le chœur roman fut démoli vers la fin du XIe siècle, et qu'en l'an 1110, l'on commença la construction du chœur actuel, l'un des monuments les plus vastes et les plus hardis de l'art gothique."

[5] "*Recherches sur l'Histoire et l'Architecture de l'Eglise Cathédrale de Notre Dame de Tournai.*" 1842.

[6] "*Histoire de Tournay par Jean Cousin,*" *Douay, MDCXX.*

The interior of the Cathedral affords an excellent specimen of pointed architecture. The choir is separated from the nave by a highly decorated rood-loft of three arches with numerous sculptured figures under canopies. Above the loft is a rood of very large size, with figures of the Virgin and St. John at the foot (without which a rood was not deemed complete) profusely adorned with colours and gilding.

The font, situated at the west end of the nave, has an elaborate Gothic crane of iron attached to the wall near it, for the purpose of supporting the cover, now removed. One of the chapels in the north aile of the nave has a balustrade or low screen of coloured marbles, exquisitely sculptured in the style of Louis XIV. And under the arch which separates the choir from its side aile, on the north side of the grand altar, is a sculptured stone tabernacle of very elaborate richness, reaching the whole height of the arch, perhaps about 30 feet. It is a hexagon in plan, tapering upwards to a point, and is supported on six small pillars round its circumference, and one in the centre.[7]

The pulpits found in the Belgic churches are in many cases remarkable for their large size, the profusion of materials employed, and their elaborate workmanship, rather than for good taste and propriety. The pulpit in the cathedral under notice (situated as most of them are, on the south side of the nave) represents the conversion of St. Paul. The saint and his horse are on the ground; on the west side of them stands the figure of a man gazing with astonishment, if I remember rightly, at the miracle; a huge mass of rocks and trees supporting angels and birds forms the chair itself. Behind rise two lofty fir trees, from the stems of which, about midway, extends the canopy or sounding board, adorned with angels and other carved decorations.

The pulpit in the Cathedral at Malines (a most interesting town) represents the same subject, but is differently arranged. St. Paul and his horse are on the ground at the foot of a mass of rock forming the body of the pulpit. Our Saviour on the cross, the Virgin, and other figures, enter into the composition; a stem of a fallen tree serves as a rail to the stairs: and a continuation of the rock work, from which the Holy Spirit in the shape of a dove, descends over the head of the preacher, forms the canopy.

In the church of St. Andrew, at Antwerp, the pulpit represents Andrew and Peter called from their nets by our Saviour. It is ascribed to Van Hool and Van Gheel. The pulpit in the Cathedral of the same city is a curious composition, consisting of twining shrubs and birds, said to be the work of Verbruggen. This artist also executed the pulpit in St. Gudule, at Brussels, which represents the expulsion of Adam and Eve from Paradise, and is perhaps better known than any of those I have already mentioned. The pulpit at Nôtre Dame, in Brussels, is a representation of Elijah fed by ravens. In some cases part of the sculpture is in wood and part in marble; as for example, in the Cathedral at Ghent, where the pulpit is of large size and elaborate design, embracing many figures.

In 1838 the writer laid before the Royal Institute of British Architects, a series of drawings illustrative of the ruins of the ancient monastery of St. Bavon in the city last mentioned, namely Ghent. These remains are situated in the old citadel on the eastern side of the town near the Antwerp Gate, a quarter not generally visited. They consist chiefly of a large rectangular building unroofed, the remains of cloisters, and a small octagonal building of two stories, (known as the chapel of St. Macaire) communicating with the cloisters and standing within the square court surrounded by them. The accompanying sketch (Fig. 3,) represents the interior of the lower story of the chapel which is much more perfect than any other part of the building. It is vaulted with rubble stone with flat shallow ribs diverging from the centre, and terminating in large corbels of columnar form. The vault has been covered with stucco, and ornamented with colours, now for the most part destroyed. One of the eight sides of the building is wider than the others, for the purpose of admitting a double archway of the cloisters, and a second side is occupied by an

[7] In the church at Léau, a place little known, there is a tabernacle of somewhat similar outline in the style of the *Renaissance*, and of very extraordinary workmanship.

altar, the top stone of which is marked, as is often the case with ancient altar stones, with five small crosses, one at each corner and one in the centre, the latter being the larger.[8] Each of the other sides has a semi-circular arched way in it. The building is paved with black and red tiles about 4 in. square each.

In the rectangular building and cloisters which present the work of several periods, the columns where they remain are very short, and have leafed capitals similar to some in Tournay Cathedral. They are formed of the grey Tournay stone, and in some few instances have octagon shafts as is also the case in the Cathedral. The arches of the cloisters were pointed; they were formed of brick, with stone ribs and corbels (sculptured with foliage and figures), and were of more recent date than the walls. The rectangular building is paved with red, yellow, and black, glazed tiles of various shapes and sizes (some being very small) disposed in patterns.[9]

The history of this building ranges over a considerable period. In the year 636, King Dagobert of France, sent St. Amand to Ghent to preach Christianity. St. Amand having made many converts, founded two monasteries, one of which was on the site of the remains in question. A few years afterwards, Allowin, surnamed *Bavon*, was induced by the teaching of St. Amand to quit the world, and having given the whole of his property to the latter monastery, obtained permission to construct a cell in the neighbouring wood, where he died in 654. The monastery then took his name, a church was dedicated to him, and the whole quarter was termed, for many years, the town of St. Bavon. In 816, the monks fled to avoid the Normans, and took refuge in England. John of Gaunt was born in this monastery in 1341, and at the beginning of the 16th century the whole establishment was destroyed, in order to construct a citadel on the site.[10]

In the "*Notice Historique de Gand*" it is stated that in 1067, Baudouin, Bishop of Noyou, and Liebert, Bishop of Cambray, consecrated the church of St. Bavon, and deposited there, in a private chapel, the relics of St. Macaire, who, it was supposed, had freed the city from the plague by his prayers, some few years before. The style of the octagon building before mentioned, still called the chapel of St. Macaire, agrees with this date satisfactorily.[11]

[8] The crosses upon ancient altar stones were intended to mark the spots anointed with chrism at its dedication. A Pontifical printed at Rome in 1595, and now preserved in the British Museum, shows that a bishop when consecrating a church, was enjoined to mark with his thumb dipped in the chrism, twelve crosses on the walls of the church, and others on the door, altar, &c. See *Archæologia*, vol. XXV, p. 243, 275.

[9] The area of the cloister is about 100 feet square; the diameter of the octagonal building is about 20 feet.

[10] The abbot and monks were removed to the cathedral church of St. John the Baptist, in the city of Ghent, from that time called the church of St. Bavon.

[11] I cannot omit mentioning with reference to Ghent, that M. L. Roelandt to whom the city is indebted for many important buildings, (amongst them the most elegant little theatre and ball-room that I know of,) is engaged upon a new *Palais de Justice* of large extent. The window dressings of the principal floor have more than ordinary importance given to them, and form a principal feature in the façade. They consist each of two disengaged Corinthian columns supported on corbels, with entablature and pediment, and corresponding pilasters on the face of the building.

CANDIDUS'S NOTE-BOOK.

FASCICULUS XLV.

> "I must have liberty
> Withal, as large a charter as the winds,
> To blow on whom I please."

I. Although not propounded *ex cathedrâ*, the doctrine broached by the Premier Professor, has made quite a sensation, filling all with surprise, and some with a panic feeling. It is the opinion of more than one in the profession that our architectural Professors are nearly all bewitched. As if it was not enough to have Hosking preach down Vitruvianism, we have now Cockerell preaching up rank architectural Radicalism. He goes to the extent of turning every thing topsy-turvy, without regard to those most comfortable of all things—our prejudices. What is to become of our reverence for precedent and authority, if copyism is henceforth to be proscribed, and every one expected to give us his own ideas. It may be all very well for those who possess taste, and have ideas of their own; but then what is to become of those poor devils who have none? If they must neither borrow nor steal, their fate will be hard indeed. While Professor Pugin would merely lead us back to the "dark ages," bidding us look for light and enlightenment there, the Royal Academy Professor would fain turn us adrift, to grope about in more than Egyptian darkness. Surely it is better to be tethered to a stake with a yard or two of rope, than to have the precious liberty of rambling at will blindfold among pitfalls and precipices. So, at any rate, think some. After copyism has served them so well, they must now hear it reviled by the ugly epithets of "dull" and "unmanly"! and that by a Professor, too! Why, he might as well have called it *stupid* and *old-womanish*, for that was, no doubt, his meaning. As to *invention*, that is, of a truth, most venturesome work, but then, be it remembered,

> "Things out of hope, are compass'd oft by vent'ring."

II. It argues very great forbearance on the part of Welby Pugin that he has not had a fling at Abbotsford, for it is certainly quite as miserable and trumpery as any of the architectural "monstrosities" he has shown up in his "Contrasts," or quizzed in his "True Principles," although concocted out of the ideas of so many persons who were successively consulted by the "Great Magician," but who have shown themselves to be no conjurors. Stark, Terry, Burn, Blore, Atkinson, all prescribed in turn, and bedoctored till they bedevilled it. Whichever be the best of Scott's works, Abbotsford is decidedly his worst—mere "Carpenter's Gothic," and a "Tea-Garden Castle." Fortunate would it be for the credit of his own taste, and also for the credit of those employed upon that pet fancy of his, were it to be demolished at once, instead of being piously preserved as a monument of Scott's *virtuosity* in architecture. Attempts in the Gothic style by Scotch architects are almost without exception intolerably bad, many of them utterly contemptible. Taymouth Castle, about which the newspapers made so much fuss a few months ago, is in point of architecture, most miserable. The noble owner of that big house possesses an infinitely superior specimen of architecture in a small one called the Forest Cottage, which he has lately erected in Inveroran. Homely in character, as its name denotes, yet at the same time something more than a mere cottage, it idealizes that character most happily, bringing forward some of its most picturesque traits, without any paltry affectation. It is withal eminently picturesque, which is more than can be averred of those things which pretend to be "Picturesque" by title, and for the nonce.

III. That the lord of Abbotsford himself could be sufficiently severe upon other persons' architectural whims, is evident from a postscript of a letter of his to Mr. Morritt, of Rokeby Park, and who was then at Brighton; saying, "Will you do me a favour? Set fire to the Chinese stables, and if it embrace the whole of the Pavilion, it will rid me of a great eye-sore"!! As this was written in the February of 1826, immediately after the crash that laid low his fortunes, and reduced him to beggary—at any rate to that sort of nominal beggary which thousands would call luxurious affluence—hardly is it to be supposed that his so expressed opinion of the Pavilion at Brighton was a mere sally of wantonness and *gaieté de cœur*. The Pavilion might have been rendered a good specimen of the style it pretends to, and so far have been satisfactory, whatever may be objected to the choice of such style for such purpose. Instead of which it is a finical and insipid, not to say paltry imitation of that style, with little character than that of toyishness and gimcrack, certainly with no "heartiness of character" about it, nor any *gusto*. The "pimping pagoda taste" of George IV. is not yet extinct in the family, for a Chinese conservatory, or something of that sort, is now erecting in the gardens of Buckingham Palace, but whether it is of porcelain, or common crockery quality, is not said.

IV. Were the reviewers to pay Mr. Gwilt in his own coin, they would say nothing of his book, except that, being the work of a living contemporary, delicacy prevented them from expressing any opinion relative to it; besides, their silence would be far more gratifying than any remarks, however complimentary, from a class of critics whom Mr. Gwilt himself denounces as a set of meddling blunderers and blockheads. He has shown himself most dreadfully sore upon the subject of reviewers and anonymous criticism, and for no other reason, it appears, than because an article in the *Foreign Quarterly* spoke in commendation of Schinkel and the German school of architecture. Any other person than Mr. Gwilt would have been thankful for the information there first conveyed upon the subject, whether he agreed with all the writer's opinions or not: whereas the meek Joseph assailed him as virulently as if that article had been a personal attack upon himself, and spluttered in a very big strain about "small fry" writers and anonymous critics—or rather those who set up for critics, though utterly ignorant of the subjects they profess to treat. Does Mr. Gwilt then suppose that professional men never write in literary journals, on subjects connected with their own pursuits? Is he not aware, poor man, that among the anonymous scribblers in the periodical he fell foul upon, there was no less a nobody than Sir Walter Scott? Can he be so ignorant as not to know that Cowper, Byron, Southey, Moore, Hallam, Brougham, Horner, the Rev. Sydney Smith, not to mention Bishops, have been anonymous reviewers? It will be well for him should he not find out at last, that it had been better had he condescended to publish anonymously, himself. None will envy him the fame he will now get by not doing so.

V. "Nothing is so tiresome," says Sir Walter Scott, "as walking through some beautiful scene with a *minute philosopher*, a botanist, or pebble-gatherer, who is eternally calling your attention from the grand features of the natural picture, to look at grasses and chucky-stones." *Mutatis mutandis*, this may be applied to those minute critics in architecture who attend chiefly to inferior matters, such as the proportions or correctness of an order as an order, without regard to any further effect, or its coherence with the rest of the building. Any thing of that kind which happens not to be in distinct conformity with standard, and therefore only general, rules,—which we are rather to be guided by than tied down to, is at once pronounced by them to be faulty and incorrect, yet at the same time they can tolerate infinitely greater faults, far more reprehensible licenses, and that which is the greatest defect of all, let the style be what it may, the utter want of all artist-like feeling. By a minute critic, however, is not to be understood one who examines merely the minutiæ and details of a building—for that is more than every one of the tribe is capable of doing: but one who looks at every thing piecemeal, and who dwells exclusively upon individual particulars and detached circumstances, without taking into consideration whether there be any thing to call for, to justify, or to account for what he only perceives to be uncommon. Your minute critic is generally a staunch stickler for precedent, and not without reason, since precedent and authority are the crutches which help him along. Deprived of their aid, he comes to the ground. In any case out of the ordinary course he feels quite *put out*, and unable to make any thing of it, takes his revenge by pointing out what does not accord with usual practice, and therefore, as he will have it, a blunder or a solecism. How the minute philosopher chuckles when he detects some *homœopathically* small infringement of a mere pettifogging rule. Yet how obtusely blind is he apt to show himself in regard to every thing which does not come within the compass of rules and routine.

VI. By no means would it be amiss were public spirit and architectural zeal to be displayed in completing and giving the finishing touches to some of our modern buildings, as well as in the restoration of decayed ones. Many there are which admit of being greatly improved by corrections, and by omissions in them, more or less obvious, being supplied. Such is certainly the case with the National Gallery for one, and there even seems to have been some idea at one time of doing something more to that building, Barry having actually been consulted on the subject. Greatly might the United Service Club House be improved by giving it a cornicione, and throwing more spirit and richness into its other features. Nay, perhaps even the Conservative might be converted into a tolerably satisfactory design, were *carte blanche* for such alteration to be granted to some one who possessed both ingenuity and taste. At all events we may now expect to find that that building has served as a wholesome warning to the architects of the forthcoming new Conservative Club House in St. James's Street, and that they will show themselves Radical Reformers in point of architectural taste.

EXPRESSION IN ARCHITECTURE.

THE expression, or as it is sometimes termed, the language of architecture, is a subject which has engaged the attention and employed the talents of many writers, both amongst professors of the art and others, nor is it at all uncommon to hear it said that every building which makes any pretensions to style and taste, should express by its design and character, the purpose for which it is intended. Although it is by no means my intention to deny that buildings of almost every class are capable of great and varied expression, yet to suppose that this expression may be varied so as to indicate all the different purposes of modern buildings appears to me as absurd as to deny all power of expression to the art. The characters of sublimity, majesty, grandeur, gaiety, or gloom, may be and frequently are imparted to a structure by the skill of its designer; but this is very different from the building indicating the intended purpose of its erection. We may see this by considering that gloom and solemnity are features equally characteristic of a prison or of a tomb, that grandeur and majesty are qualities of expression as appropriate in a palace as in a senate house, whilst gaiety and elegance are generally considered as characters equally to be impressed on the decorations of the private house and of the theatre. A great number of buildings must, indeed, always share in the same external style and expression, though erected for and adapted to very different purposes. We might as well expect the face of each individual whom we meet to express his particular pursuit and profession, and lay open to us his thoughts and intentions, as to look upon the façade of a building as the index of the purposes for which it was erected. The human face, indeed, is considered, and with unquestionable propriety considered as the index of the soul, as the outward sign by which we may read the feelings of the man, and being accustomed from the dawn of reason, perhaps intuitively, perhaps from experience acquired in infancy, to consider the features as indicative of the various passions, and our more mature years confirming this experience, we become so firmly convinced of the truth of these principles as to rely on the inferences we draw from them; and believing all men subject to the same feelings, the same joys and sorrows as ourselves, we make no distinction in our application of them; but consider, that whatever may be a man's rank, his race, his sation, or his name, without regard to climate or complexion, whether he be an inhabitant of the polar circles, or the torrid zone, we may read in his face the passions of his soul. But though he may thus plainly and universally read the feelings of the man, the cause of those feelings is yet hidden from us; and although the expression of the features we look upon may induce in us corresponding emotions, we are unable to divine its origin. We may thus see the emotions of joy or fear spread rapidly through a crowd ignorant of their cause; each individual being immediately affected by his neighbour's animated look and gesture, or though himself remote from danger, becoming at once alarmed by the fear expressed in surrounding faces, which indicate that something unknown is to be dreaded, by its portentous indistinctness, rendered yet more fearful. In the arts of painting and sculpture, the artist copying the human face and figure, gives to his productions the expression he may choose, and in proportion to the intensity of that expression is the emotion raised, but the cause of such expression is sought for in the accessories, or combinations of the piece; and our experience of human feelings leads us to judge whether the passion expressed is in accordance with its exciting cause. If then in these most expressive arts the feelings excited do not lead us to the reason which induced the artist to give such particular expression to his work, if we are liable to be deceived in interpreting the meaning of allegorical painting and sculpture, how shall we in architecture, where neither nature nor experience teach us to decide, how shall we say what particular character shall indicate a particular building. We have here no standard of expression; the ideas of different nations on this subject are as various as their languages: and in examining the remains of ancient edifices, we do not decide upon the purposes for which they were built, from their architectural character, but the acccessories and combinations of their construction.

The Gothic style, which is by us considered as peculiarly characteristic of a church, would most assuredly not be viewed in the same light by an ancient Greek. One of our large churches, or cathedrals, would unquestionably produce emotion in the breast of any man who had a soul to feel; but this, I am persuaded, would arise from the grandeur of the structure, from the insignificance into which the spectator sinks while gazing through "the long drawn aisle," or looking up to the "arched and ponderous roof," and from the majestic evidence of superior constructive skill around him, and not from any feeling that such a style proclaimed, by its silent but unerring expression, that he was in the House of God. As on the human face we may read the feelings of the mind, may trace gaiety, gloom, resolution, or despair, so may we be impressed by the design of a building with the emotions corresponding to sublimity, grandeur, magnificence, or elegance; but as we cannot determine the cause of the passions expressed upon the human features, so we cannot impart to any structure, vary its character as we may, the power to express whether it be a temple, a palace, a senate-house or an exchange. And as mankind differ as to the expression proper to be given to a statue or a painting, so will they disagree as to the character proper for a building, nor can we hope that architecture shall speak in the same language to us all, until all shall not only have been educated alike but shall have acquired the same prejudices, habits, tastes, and feelings.

A. D.

THE VELOCITY OF WATER IN VERTICAL PIPES.

We have received a voluminous communication from Mr. Shuttleworth, purporting to be a reply to the notice in our December number, of his system of railway propulsion. The extreme length of his letter, which occupies thirty closely written pages, would be a total bar to its insertion, even were it an argumentative treatise instead of being almost entirely discursive. We have received from another correspondent, however, a communication on the same subject, deserving much more attention, in which the writer states argumentatively his objections to two of the positions introduced incidentally in the article on Mr. Shuttleworth's hydraulic railway. The question of the velocities acquired by water flowing down vertical pipes is, indeed, important and interesting; we shall therefore, after allowing our correspondent to speak for himself, pursue the inquiry, not only for the purpose of defending our previously expressed opinions, but with the view of arriving at some satisfactory conclusions on a subject that has given rise to much discussion, and respecting which, as it appears to us, very erroneous notions continue to be entertained.

The following is the letter to which we refer.

"*London, December* 21*st*, 1842.

"Sir—Agreeing with the writer of the remarks on Mr. Shuttleworth's Hydraulic Propulsion system, which appeared in your *Journal* of last month, that it is a pity to see so much talent, ingenuity, labour and expense lavished upon an invention evidently impracticable, I must at the same time call into question the reasoning by which the writer has arrived at this conclusion, or at least that part of it which relates to the flowing of water through a vertical pipe; I do so more particularly, as the subject is important, and, I believe, new: also because, from the editorial character of the article, it might mislead many of your readers. I shall endeavour to show that the writer has committed two important errors in the fifth paragraph of that article; first, in explaining the uniform flow of the water in the column, by the cohesive attraction of the particles of water. Secondly, in saying that this uniform velocity is *half* that due to the height of the column of water flowing through a *small* orifice, he appears to think that, supposing the height of the water constant, the issuing velocity diminishes as the aperture increases. Now, it is evident that such is not the case, as by increasing the diameter of the orifice, the friction of the sides decreases in a greater ratio than the area of the orifice increases. This is so evident, that I believe it requires no further explanation.

"Assuming the Irishman's privilege of going backwards, I shall first endeavour to dĕmonstrate the second error, by proving the velocity of the issuing water (and therefore, as will be proved in the second part) of the whole column, to be expressed by the formula $8\sqrt{x}$, where x expresses the height, modified by the resistance of the air and friction. The friction, however, may be omitted, as being very trifling in a vertical pipe, when compared with the retarding effect of the atmosphere.

"When the water first enters the pipe, there is a slight decrease of velocity, in consequence of the "*vena contracta*," which in all works on hydraulics, is generally allowed for, by changing the 8 in the above formula to 5; it then assumes a vertical direction, its velocity increasing as the square root of the height, until the resistance of the air, increasing as the square of the velocity, becomes equal to the momentum of the water. An equilibrium then existing between the accelerating and retarding forces, the velocity would be uniform. As will be seen from the following equations, it would require an immense length of *vertical* pipe before this uniform velocity could be produced. Let v represent the velocity, x the height, s the specific gravity of water expressed in pounds, and h the number by which you must divide the square of the velocity, in order to find the resistance of the air; it is generally taken as equal to 500 lb.

"You have then three equations and three unknown quantities.

1st. $s \times v = r$, resistance of the air at the moment of equilibrium.

2nd. $\frac{v}{h} = r$

3rd. $v^2 = 64\ x$ taking 8 as the multiplier.

$\therefore\ h^2 s^2 = 64\ x$, from which x the height at which the equilibrium between the accelerating and retarding forces exists, would be found. As might be expected this number would be very great. The above equations are also useful in finding the velocity due to any given height when the water flows *directly* into the air, but in the case of the hydraulic railway, where the vertical pipe deflects into one horizontal, the velocity of the water issuing from the vertical pipe will be gradually diminished, in consequence of the friction of the *horizontal* pipe, and therefore the velocity of the *whole* column (as will be seen) will be reduced to that of the water issuing from the extremity of the horizontal pipe.

I shall next proceed to show that cohesion does not account for the uniform flow of the whole column so simply, and consequently not so well, as the pressure of the atmosphere on the surface of the water. For suppose that in some part of the passage of the water through the pipe, two consecutive portions separated, a vacuum would be formed between them, consequently the atmosphere would act as an accelerating force on the upper portion, and as a retarding force on the lower portion, and evidently would cause the junction of the two parts—the vacuum then ceasing, the whole column would move together. A familiar illustration of this explanation is afforded by the well-known experiment of half-a-crown, and a piece of paper of the same form placed at the back, falling together to the ground. It is not the action of gravity alone which makes them fall together, but the pressure of the atmosphere on the half-a-crown. It is, I believe, clear, if these results be correctly deduced from sound principles, that cohesion does not satisfactorily explain the uniform flow of the column of water, and certainly does not reduce the velocity by one half, and consequently demonstrates the errors of the fifth paragraph, alluded to at the commencement of this letter. Some curious results, explaining the uniform flow of the column, even in the case of the atmosphere not acting on the surface of the water, might be deduced from the above equations, by differentiating them.

"You would oblige me by inserting this letter.

"I remain, Sir,

"Your obedient servant,

"T. F——N."

Before we reply to the two points to which our correspondent particularly directs attention, we must correct a misapprehension he appears to have, respecting the statement of the diminution of velocity by increase of aperture. What we stated was, "that if the size of the aperture *approximate to that of the pipe*, the velocity will be diminished, and that if the aperture be of the same size as the pipe, so that the *whole column* must fall as rapidly as the issuing fluid, the velocity will be diminished one half, without making allowance for friction."

We never intended to assert, as our correspondent appears to imagine, that the velocity of water through a small aperture would be greater than through a large one, unless the aperture be increased so much as to bear a sensible proportion to the size of the containing vessel.

We shall reverse the order in which our correspondent has considered the subject, and direct attention in the first instance to the cause of the continuously equal flow of water down a vertical pipe, because the main question rests on the admitted uniform flow of the fluid. The initial and the final velocities being the same, there must, as we contend, be a deviation in this case from the usual law that regulates the velocities of falling bodies. With respect to the cause of this equal fall of water, the difference between us is rather a difference in form than in substance. Our correspondent admits that the flow is uniform, but he attributes it entirely to the pressure of the atmosphere; we attribute its immediate cause to the cohesion of the particles of the fluid, without which, the pressure of the atmosphere could have no effect. Were it not for the coherence of the particles of the water, they would immediately separate in falling, and the particles would fall independently and with different degrees of velocity. Their coherence prevents this. Each particle of water in the pipe coheres to the particle immediately above it, with sufficient force to overcome the minutely different degrees of gravitating momentum, due to the difference in their respective times of falling. The effect of this continuity of coherence, transmitted from particle to particle, is to form a running *rope of water* in the pipe. This rope of water, if we may be allowed the expression, being supposed of equal size throughout, must have an equal velocity in every part of its course; for as water is practically incompressible, a motion communicated to one part of the fluid in the pipe will be communicated to all other parts as effectually as if it were a solid moveable column. It is true that the pressure of the atmosphere tends materially to prevent the separation of the water flowing down a vertical pipe, in the manner stated by our correspondent; but were it not for the coherence of the fluid particles, the pressure of the atmosphere would have no effect. Small round shot, for example, would not fall down a vertical pipe in a continuous stream, but in separate particles, and with differing velocities. The experiment of the half-crown and piece of paper, adduced by our correspondent as an illustration of his explanation, is not, we conceive, applicable to the purpose. It is not the pressure of the atmosphere on the paper that causes it to fall in the same time as the half-crown, for it is well known, that in a vacuum, even a feather will fall to the ground as soon as a guinea. The cause of the paper falling through the air in the same time as the half-crown, must be attributed not to the pressure of the atmosphere, but to the avoidance of resistance from the air, in consequence of the paper following closely *in the wake* of the half-crown, which sustains all the resistance.

It will be a curious, and we believe a new point, to ascertain to what extent atmospheric pressure influences the flow of water down vertical pipes. Many of our readers may have noticed the force with which water in a reservoir is drawn into the orifice of a long vertical pipe as the fluid flows down. This force results from the weight of water in the pipe, and from the pressure of the atmosphere on the surface of the water in the reservoir; the one tending to separate the cohering column of fluid, and to produce a vacuum, the other pressing in the water to counteract this effort. If the hand be held on the orifice it is pressed against the aperture with a force corresponding, within certain limits, to the height of water in the pipe. Were the length of the pipe greater than 33 feet, so that the weight of water surpassed the pressure of the atmosphere, a Torricellian vacuum would be produced, between the surface of the water in the pipe and the hand, and the latter would be drawn, or forced, against the orifice with a pressure equal to that of the atmosphere. No additional length of pipe would then increase the pressure. The vacuous space between the hand and the water in the pipe would be increased, but the pressure would evidently remain the same. The inferences to be drawn from these premises, are—first, that the velocity of the flow increases with the length of the vertical pipe, until the column of water balances the pressure of the atmosphere; secondly, that when an equilibrium is established between the column of water and the pressure of the atmosphere, the maximum effect is produced, and no additional length of pipe will add to the velocity of the flow from the reservoir.

Having thus disposed of the first objection raised by our correspondent, we shall proceed to consider the point on which we more essentially differ. Our position is, that the velocity with which water issues from a vertical pipe is half the final velocity due to the height of the column. Our correspondent disputes this position; but instead of adducing arguments to prove that it is an "important error," he takes for granted the very question in dispute, and thereupon founds a formula for determining another question, with which the present has no immediate connexion. We affirmed, that the velocity of water flowing through vertical pipes differs from the velocity of water issuing from an orifice, in the bottom of a large column of equal height; we stated, also, the cause of this difference, and its amount. Our correspondent, by way of refuting this opinion, *assumes that there is no difference;* and then proceeds, on the ordinary data for calculating the velocities of falling bodies, to estimate the height from which a body must fall, before an equilibrium is established between the accelerating force of gravitation and the resistance of the air. We shall not imitate this summary process of disposing of the subject in dispute, but shall endeavour to show that, according to the generally recognized laws of motion, the velocity of water issuing from a long vertical pipe, cannot be the velocity which is due to the height; and we shall then show the cause of this apparent deviation from the usual law.

In the first place, it must be borne in mind, that it is admitted, that a pipe having the same diameter throughout, continues full during the flow of water through it; therefore, as water is incompressible, the velocity of the water must be the same at the top of the pipe as at the bottom. Suppose the pipe to be 16 feet vertical, and to be covered with water just sufficiently to keep it constantly full. Then, as the velocity due to a height of 16 ft. is, in round numbers, 32 ft. per second, if the water issue from the pipe with that velocity, the same velocity must be communicated to the fluid in all parts of the pipe, as it forms part of the hypothesis that the velocity is uniform. We should, therefore, be obliged to assume the existence of some force, which could communicate to the water flowing into a tube from a state of rest, a velocity equal to that it would acquire after falling freely through 16 ft. It can scarcely be asserted, that the pressure of the atmosphere would communicate this additional velocity, for the upward pressure on the fluid at the bottom of the pipe must always counterbalance the downward pressure on the top; and were the pipe a very long one, the upward pressure would be the greater, owing to the increasing density of air at lower elevations. There is, indeed, no rationally conceivable force called into action but gravitation; and if the whole column of water instantly acquire a velocity, which is due only to a fall through its whole length, the force of gravitation must, in some unaccountable manner, be doubled; for the momentum of a column of water, moving with a uniform velocity of 32 feet per second, is equal to the mean momentum of the same weight, were its motion to increase progressively from a state of rest to a velocity of 64 feet. There is not, however, the slightest ground for assuming that the force of gravitation produces any such effect. The final velocity of a body falling freely through 16 feet is, within a fraction, 32 feet per second, the mean velocity of the fall will therefore be one half, or 16 feet per second; and that, we contend, is the velocity with which a continuous and equal column of water would fall through a vertical pipe 16 feet long; putting out of consideration the friction of the pipe and the resistance of the air. In the case of water issuing through an orifice, the velocity due to a height of 16 feet is 32 feet per second, when the areas of the column and of the orifice are greatly disproportioned; but it appears from the preceding reasoning, that *the whole column* of fluid would issue with only half that velocity, which was the point to be proved.

Having, therefore, shown that the conclusion at which we have arrived may be deduced as a necessary consequence of the continuous uniform flow of water in vertical pipes, we shall next proceed to consider the conditions of water when flowing down vertical pipes, and when issuing from an orifice; and we shall endeavour to arrive at the same conclusion by a different process of reasoning.

It was demonstrated by Daniel Bernoulli, that the impulse of a "vein" of fluid falling perpendicularly, is equal to the weight of a column whose base is the area of the vein, and whose height is twice the fall producing the velocity. For example; if v be taken as the final velocity of the efflux acquired by falling freely from a height h, then it is well known that a body falling with the final velocity, during the time of the fall, will pass through a space equal to $2\,h$, or twice the height. As the water commences and continues to flow through an orifice with the final velocity due to the height, the quantity of water falling through the aperture in a given time is double the quantity that would flow through it if the flow commenced with the initial velocity of a falling body, and progressively increased to its final velocity.

Bernoulli's hypothetical vein of fluid was without any tangible boundaries, and the particles of the fluid in the vein were supposed to be pressed against, and changing places with, all the other particles in the containing vessel. It is this transmission of the pressure through the fluid, that causes the difference between the imaginary vein of fluid and a real pipe passing from the orifice to the surface. When the communication between the orifice and all other parts of the vessel is free, the water near the orifice is forced out, not only by the weight of the particles immediately above it, but all the particles of fluid are pressing towards the aperture and contributing towards the effect. The space occupied by the particles of fluid forced through the aperture, is immediately filled by other particles sustaining equal pressure. The continuity and equality of the pressure are thus preserved, which consequently maintains an equal and continuous flow, the height of the fluid being supposed constant. The velocity at the first moment of efflux is the same as would be acquired by a body falling freely from the surface, because the whole gravitating effects of the perpendicular vein of fluid instantly act on the portion of water above the orifice, and this action is continued, because the pressure remains free and constant. When a vertical pipe passes from the orifice to the surface of the water, so as to exclude the action of the surrounding fluid, the conditions are essentially changed. Suppose such a pipe to be filled with water, the base of the vein of water within, *when at rest,* would sustain the same pressure as another equal area on the bottom of the vessel, the heights being equal. But as the force then acting on the lowest lamina of the fluid is produced solely by the pressure of the laminæ of fluid above, were the lowest one to separate from the upper by the impulse of this pressure, the force would instantly cease, for the lamina immediately above the lowest not being impelled with equal force, would not have the same velocity. The adhesion of the particles of water would, however, prevent the falling vein of fluid from being divided, because the difference of the force acting on one minute lamina, and that acting on the fluid particles immediately above, would not equal the cohesive attraction which holds them together. The vein of fluid would, therefore, cohere and fall through the vertical length of pipe as a solid mass. Again; as the upper part of the vertical vein of fluid in the pipe would be as free to move under the influence of gravitation, when the supporting base was removed, as the lower portions of the vein, and as the force would be exerted in the same time, the velocities they would respectively acquire, would be the same; and they would fall through equal spaces in equal times. The length of pipe we have assumed to be 16 feef, therefore, it would be emptied by the fall of water in one second, the final velocity on issuing from the pipe would be 32 feet per second, and the mean of the initial and final velocities would be 16 feet per second.

If we suppose the water just to cover the top of the pipe, so as to keep it constantly full, the flow of water would then, it is admitted, be uniform instead of being accelerated, as in the preceding illustration. The water at the lower portion of the pipe would be retarded in its fall, by the continuity of cohesion between the particles of the fluid in the falling vien; or, in other words, the velocity due to the fall at the bottom of the pipe, would be diminished, and a greater velocity than is due to the fall, would be imparted to the fluid in the upper part of the pipe, to produce a mean velocity. The mean between the initial velocity and 32 is 16. Thus, in whatever mode the question is considered, we arrive at the same conclusion, that the velocity with which water issues from a vertical pipe, (not exceeding 33 feet in length,) is one-half the velocity due to the height of the column.

We trust we have proved, even to the satisfaction of our correspondent, that there are no errors in our reasoning on this subject; and that he was induced to think so, in one case by a misapprehension of our meaning, and in others by a hasty consideration of the main proposition: which appears, though in reality it does not, to deviate from the recognised laws of hydrodynamics. The theory of the flow of water through pipes well deserves a more full consideration than we have now time or space to bestow upon it, and to which we shall probably return.

JAMES NASMYTH'S PATENT DIRECT ACTION STEAM FORGE HAMMER.

THE truly valuable qualities possessed by wrought iron as the material of all others the best adapted to withstand force, has rendered its use as a mechanical agent almost universal, so important are the purposes it serves in enabling man to combat with the elements, and as it were bend them to his will, that we may almost measure the progress of civilization in any nation by the quantity of that inestimable material they convert to their use; hence it is that Great Britain owes no small portion of her power, wealth, and mechanical supremacy to her superior knowledge of the use and capabilities of this the most serviceable of all substances.

National improvement is always indicated and accompanied by increased consumption (by reason of increased application) of wrought iron; by its use man first merges from the savage state, and by its extended employment the most civilized nations not only maintain, but advance in their improvement. It is, perhaps, unnecessary here to remark how entirely we are indebted to wrought iron for the services of the steam engine; and its innumerable progeny of happy results, to say nothing of railways and steam vessels, in the very hulls of which, as well as in other ships, it is rapidly manifesting its superiority over wood, and so giving to the world another magnificent evidence of its all but universality of application. Hence it is that few mechanical improvements are of more real importance than those which relate to the manufacture of wrought iron, not only in respect to its production in the first instance, but also to our increased facilities, and means of working it into such forms as may be rendered desirable and necessary.

By a property almost peculiar to wrought iron, namely its all but unmeltableness, its applications would have been very limited, by reason of the difficulty we should have experienced in fashioning it into any required form, but by another peculiarity, namely its capability of being welded, we have the loss of convenience arising from its unmeltableness *more* than made up to us, and where we add to this its extreme malleability, by which property and by the assistance of heat, it is capable of being forged into any required form, our command over it is only limited by our means of applying the requisite force, whether by compression, as in the case of the process of rolling, or by blows, as in the case of forging by the hammer; this latter process being by far the most important, not only in respect to its affording us the means of giving to masses of wrought iron the requisite shape and form, but also, when the process of hammering is carried on with due energy, *while the iron is at a welding heat*, the effect of such hammering is productive of a most important improvement in the quality of the iron, as regards its tenacity and consequent capability of resisting strains without the risk of fracture, this gain of strength arising from the more intimate contact or union brought about between the particles of the iron, by reason of the more perfect expulsion of all those impurities which otherwise, by separating the particles or fibres of the iron, so impair its strength. Hence we have one of the many important reasons why it is so desirable that we should have the means of hammering iron when at the proper welding heat, *with all due energy*, whatever be the size or form of the mass in question.

The great success which has attended the application of the steam engine in the case of steam ships, and in other instances, has produced a demand for enormous forgings of wrought iron, such as paddle shafts, cranks, &c. that no small difficulty is now felt in the execution of large parts of them, having attained to such a magnitude as to be all but beyond the power and capability of the largest forge hammers to execute them.

The approach of this point of ultimate capability has long been felt, not only by the vast difficulty and expence by the ordinary means, such enormous forgings being so frequently attended by the destruction of the machinery employed, but also by the frequent occurrence of unsoundness being the certain result of inadequate means, and the exceeding the limits and capabilities of the machinery hitherto employed for the purpose, arising from a defect inherent in the principle on which such machinery has been constructed, the evils of which have been rendered more and more apparent by every successive attempt to enlarge the apparatus, with a view to endeavour to enable it to cope with the increase in the magnitude of the forgings it was required to execute.

It was with the view to remove *those defects in the principle* on which such forge hammers were constructed, and to produce such a hammer as should, in the most simple manner, attain all that was desirable in our means of forging the very largest class of work, and that in a manner infinitely more convenient, perfect, and economical, that led me to contrive my *direct action steam hammer*, which I shall now proceed to describe, and which has realized my most sanguine expectations of its advantages.

In order to give such of my readers as are not minutely acquainted with the subject, a more clear view of the advantages possessed by this direct action steam hammer over those of forge hammers of the ordinary construction, I must refer them to Fig. 1, which is intended to represent a forge hammer of the largest class, and generally arranged according to the most improved principle. According to the scale on which this sketch is made out, such a hammer would be fully what is called a seven ton hammer, and consequently adapted (so far as its principles of construction will permit) for the execution of the largest class of work.

One chief and universal feature in all such hammers, is, that the power which causes them to rise and fall, and so give out blows on the work on the anvil, consists of *rotary motion*, which originating in the *rectilinear* motion of the piston of the steam engine, is conveyed to the hammer by and through the medium of *revolving shafts*, wheels, &c., and finally reconverted into its original up and down motion by means of the cam wheel, marked D in the sketch; thus, by a very *roundabout* course we have brought our power back again into the form it first existed, namely, rectilinear motion, or as nearly so as the radial action of the hammer will permit. And what advantage have we obtained by causing our power to travel to its object by such a roundabout course? none that I ever could see; and as to the disadvantages, they are many and most serious. In the first place, there is great loss of power, on account of the very unfavourable manner in which the momentum of the fly-wheel on the cam shaft D communicates its motion to the helve of the hammer, by a jolting action most unfavourable to the economical communication of power; add to which the vast space of the forge shop, occupied by all the intermediate apparatus of a *complete* steam engine, with its requisite fly-wheels, shafts, beams, and *very costly foundations*, which, in order to endeavour to maintain the apparatus in due order, has to be made of more than ordinary substantiality; so much so that, to resist the destructive effect of the vibration given to the entire machinery by the action of the hammer, the foundations have to be made so solid

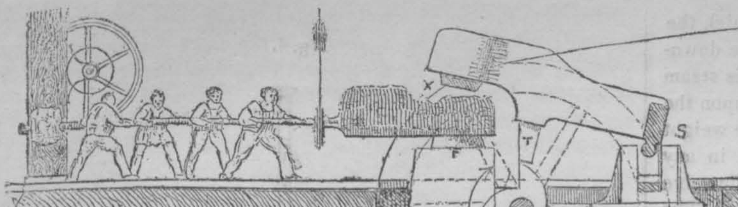


Fig. 1.—View of the Old Tilting Hammer.

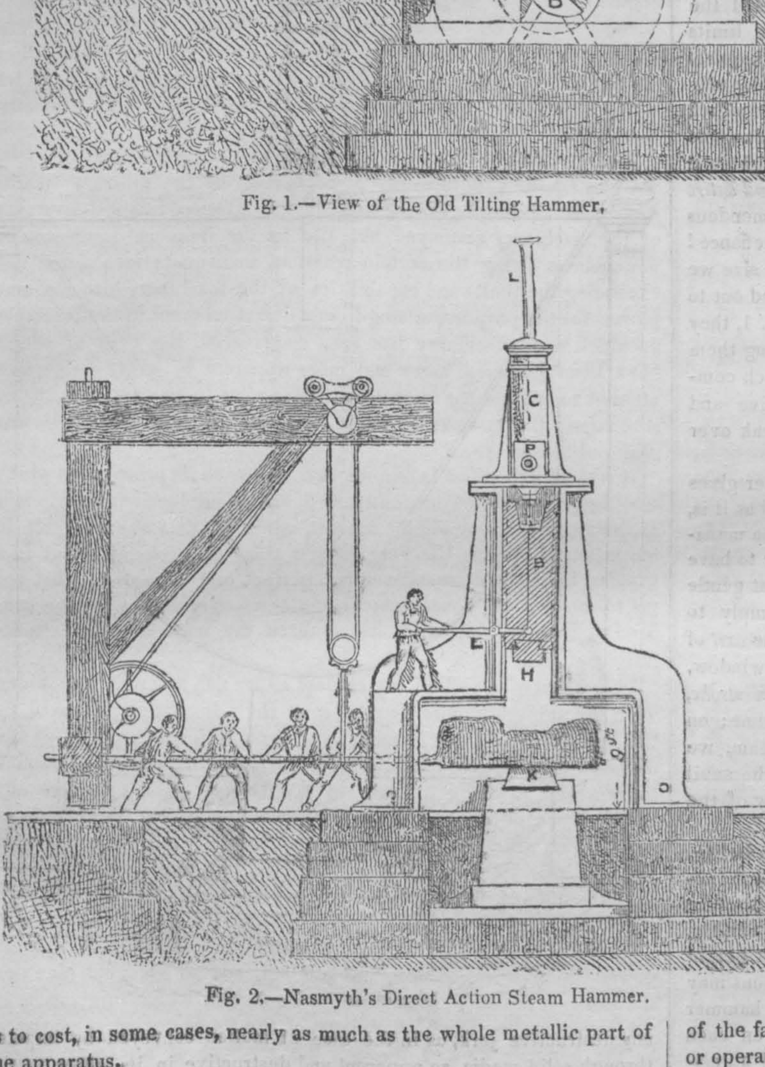


Fig. 2.—Nasmyth's Direct Action Steam Hammer.

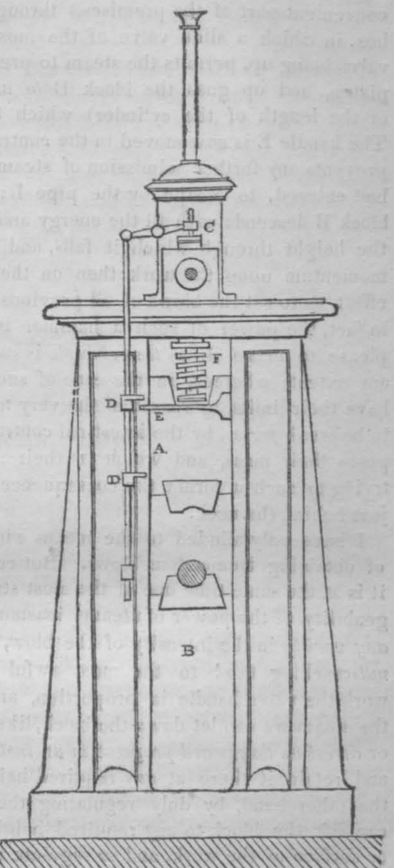


Fig. 5.—Self-acting.

as to cost, in some cases, nearly as much as the whole metallic part of the apparatus.

With respect to the action of such a forge hammer, as seen in Fig. 1, it will be found that one grand defect in principle exists, namely, that when engaged in hammering a large piece of work, as that seen in the sketch, by reason of the work occupying the greater part of the clear space between the anvil face and that of the hammer, we have thereby a slight blow when we are doing a large piece of work, and a heavy blow when we are hammering a small or thinner piece of work, which is just the very reverse of what we could desire. And in the execution of large work this is found to be a most serious evil, in as much as, from the nature of the case, we would wish to have the most powerful and energetic blows that it is possible to command. The result of this is, that neither is the mass rendered so sound as we could desire, nor is it brought to its required form except by repeated heatings, at the very great sacrifice of time and iron, in so far as, ere the limited blows of the hammer have produced the required change of form, the welding heat has gone off, and all blows after this tend rather to loosen than compact or solidify the mass. Again, we have another very serious evil, namely, the very confined limits of the space between the hammer face at its highest, and that of the face of the anvil, which renders it quite incapable of admitting or operating upon a mass of any great breadth or height; and besides having the machinery of the hammer quite in the way, in many cases we have also this other disadvantage, namely, that except for one thickness of work, the hammer face and anvil are not parallel, as will be evident on referring to the sketch, and considering that the face of the hammer acts radial to the centre, S, Fig. 1, in which it rocks. This evil is to a small extent obviated, by means being given to raise up the tail or centre, S, but this process is not only difficult, but can only be done between the heats.

With a view to relieve all these defects, I have contrived my direct action steam hammer, which is represented in one of its many forms and applications in Fig. 2.

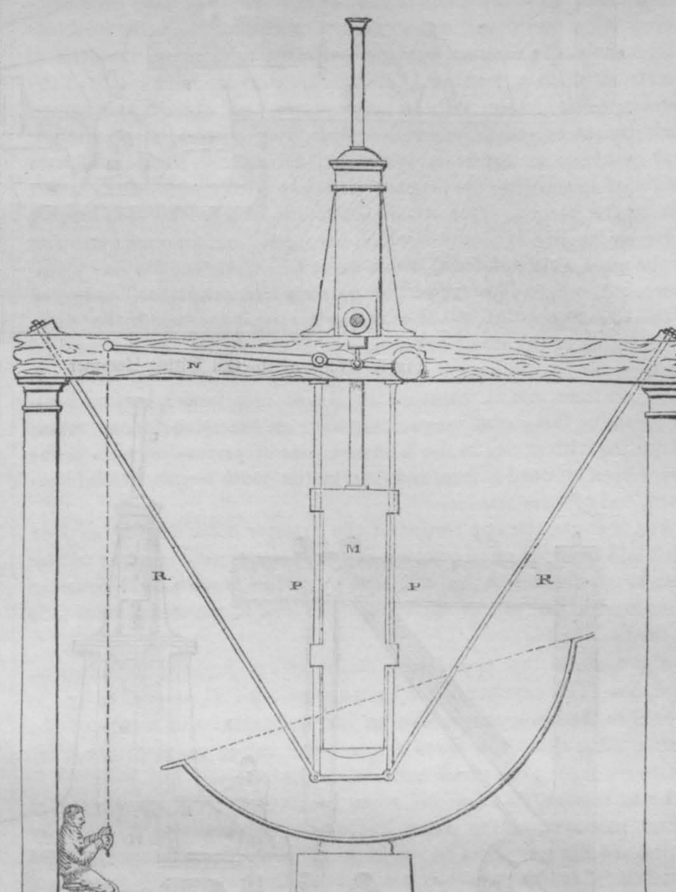
It consists simply of a cylinder C turned as it were upside down; that is, its piston rod comes out at the bottom of the cylinder instead of (as in most cases) out of the top; this cylinder is supported over the anvil K by two upright standards, O O, the end of the piston rod being attached to a block or mass of cast iron, B, guided in its descent by planed guides or ribs cast on the edge of each standard. This block of cast iron is the hammer or blow-giving part of the apparatus, while the cylinder, with its piston and piston rod, supplies in the most simple, straightforward, and direct manner, the power by which the striking block B is lifted, or raised up. *Gravity* performs the downward action for us in a most *direct* manner. In order to set this steam hammer in action, steam of such a pressure as, operating upon the underside of the piston, will a little [1] more than balance the weight of the block B, is conveyed from a suitable boiler, (situated in any convenient part of the premises,) through the pipe P into the valve box, in which a slide valve of the most simple form works. The valve being up, permits the steam to press upon the underside of the piston, and up goes the block B *to any height* (within the limits of the length of the cylinder) which the forge man may require. The handle E is now moved in the contrary direction, which not only prevents any further admission of steam, but also permits that which had entered, to escape by the pipe L; the instant this is done, the block B descends with all the energy and force due to its weight and the height through which it falls, and discharges *its full and entire* momentum upon the work then on the anvil, with such tremendous effect, as to set the blows of all previous hammers at utter defiance! In fact, the power of such a hammer is only limited by the size we please to make it, as *the principle* is capable of being carried out to any extent; whereas, in the case of such hammers as in Fig. 1, they have their limits, by reason of the very mass of material causing them to be weak *per se*, by the intestinal contraction of the iron which composes their mass, and which in their action is so destructive and trying to such a form; the consequence is they generally break over just behind the neck.

I have only alluded to the means which this steam hammer gives of obtaining tremendous blows. But energetic and powerful as it is, it is at the same time one of the most striking examples of the manageability of the power of steam; inasmuch as, when we desire to have *any variety* in the intensity of the blow, varying from the most gentle *nut*-cracking tap! to the most awful smash, we have simply to work the valve handle in proportion, and by so regulating the *exit* of the steam we can let down the block, like closing a well hung window, or *arrest its downward progress in an instant at any part of its stroke,* and retain it there at any required height at any required time; on the other hand, by duly regulating the entrance of the steam, we can lift the block to any required height, from the face of the anvil or surface of the work, and so regulate the amount or rapidity of the blows accordingly.

The form and arrangement of the steam hammer, as given in Fig. 2, is such as present experience shows to be most convenient, according to the scale on which the sketch is made out, the distance between the standards O O gives a clear space of 12 feet, namely, six feet on each side of the centre of the anvil, and six feet height clear over head, as figured in the sketch. But these proportions may of course be varied at will, as the *principle* of this steam hammer affords every facility to extention or otherwise. The space on each side of the anvil, in front and behind, being quite clear of all machinery, gives every facility to the introduction and management of the work, when we progress, as will be evident and fully appreciated by practical men.

The comparatively small space which the entire apparatus of the steam hammer occupies, may be judged of by a glance at the sketch, Fig. 2, as compared with that of the ordinary construction in Fig. 1. Had I turned the standards in the sketch, Fig. 2, so as to give a *side* or edge view, the contrast in respect to space occupied would have been much more striking. As regards the comparative original cost, any one the least accustomed to such matters will at once see the vast advantage in that respect in favour of the steam hammer, to say nothing of its vast superiority as to efficiency and little liability to derangement; in fact, so simple is it, that there is scarcely anything to go wrong. One great source of its durability in this respect is the manner in which the mass of the block is raised, namely, through the medium of *the* most elastic of all bodies—steam; which, in place of

Fig. 4.



any destructive jerk, as in the case of motion conveyed by impulse through solid media, so apparent and destructive in its effect in the case of the apparatus of the ordinary forge hammer, with the steam hammer the lifting motion is performed so smoothly as to be absolutely silent in its action, as if the great block had forgot, for the while, that it had any weight at all. I do not intend here to rival the celebrated Caterfelto by wondering at my own wonders! but truly the action of this simple but most powerful machine, is not a little striking, both in its action as well as effect. I think experience will prove that I am not too far yielding to sanguine expectations when I state, that the vast facilities which this invention gives to the treatment of large masses of wrought iron, will introduce quite a new era in the manufacture and working of wrought iron. We have now, by means of this steam hammer, a power and capability of producing forgings of wrought iron of *any* dimensions, whose soundness will give the best evidence of the value of the invention in that respect, and from the vast facilities of executing the most ponderous and acquired forms the saving of time and finish which can be attained under such a hammer will also prove that a great step has been made in the mechanical arts. In conclusion, it may perhaps be as well to remark on the valuable and important influence which such

[1] About five to six per cent more pressure than will just balance the block gives all due activity to the upward or lifting action of the block.

a hammer will have upon the quality of iron, as in the case of boiler plates and such like, the quality of which, as regards *soundness*, entirely depends on the efficient manner in which they have been hammered and consolidated in the primary process of faggoting or shingling, namely, the forming into one perfectly *solid* mass, the block of iron from which such boiler plates, &c. are rolled. Nine tenths of the defects which are met with in boiler plates, and which have caused such disastrous results, namely, defects from blisters, have arisen or may be traced to imperfect consolidation resulting from inadequate means of hammering the original mass into a truly solid block, by our having the *power* to force out all the scoria, which, otherwise lodging between the pile of pieces of which the faggot is composed, gives rise to the most serious defects, which every practical man has had to deplore. It will, in like manner, be scarcely requisite that I state any of the advantages that will arise in our having, by means of the energetic action of the steam hammer, a perfect security against unsound *anchors*, the importance of which requires no words to set forth. In short, we have now at command an almost new power, inasmuch as, by means of this steam hammer, we have an accession to our means of dealing with power in the form and state of *percussion*, such as has never been attained before, and that in the most *simple*, straightforward, and *effective* manner.

Fig. 3 shows the application of the hammer A for forging an iron shaft laid over the anvil or block B, and is made self-acting, as will be seen by a reference to the cut, that when the tappets D D come in contact with the pin or spring on the block E, the steam valve C is opened or closed.

Fig. 4 shows the application of the steam hammer for coppers, pans, &c. The hammer M works in the guides P P, suspended by the rods R to the beam above, like an inverted truss: the action of the man pulling down the lever N opens the valve, so as to admit the steam for raising the piston and with it the hammer.

I may remark, that one boiler can be made to work any number of steam hammers, as the steam has only to be conducted to each by pipes, and the power let on and shut off in the same manner as gas; and in most iron forges, the waste heat of the furnace will more than furnish the requisite steam. There are many other applications and details connected with this important invention, but reluctance to further trespass on your readers' attention, and the space of your columns, causes me to defer to a future opportunity.

But I trust the high importance of the subject will plead my excuse for the length I have allowed my remarks to extend to.

With most sincere respect,
I am, very truly yours,
JAMES NASMYTH.

Bridgewater Foundry, Patercroft.—Jan. 17.

OBSTRUCTION TO WINDOWS.

SIR—Your Old Subscriber at West Derby does not, I think, quite understand the nature of a right gained by prescription to a window overlooking a neighbours' land. In the case put by him, the right is not, as I conceive, so much to the *window* as to an *easement of light and air* through the window, and consequently "much (query, all) must depend upon the hard swearing of witnesses on both sides, as to whether a building erected near a window does or does not obstruct the light and free circulation of air." Indeed I doubt very much whether proof that a building had been erected within two feet of the window would be proper evidence to rely upon, unless it were also proved that the said building had prevented a certain quantity of light and air from finding its way to the window. With regard to question 3, it is obvious that the right being to *light and air*, and not to *space*, a building may be erected as high as the *upper side* (beyond the limits of the building act) of the window sill, it being impossible that such an erection should obstruct the free passage of either to the window.

6th January, 1843.

I am, Sir,
Yours very obediently,
R. R. A.

ON THE SEWERS OF THE METROPOLIS.

1. *Report to the Secretary of State from the Poor Law Commissioners on an Inquiry into the Sanitary Condition of the Labouring Population of Great Britain.*

2. *Address on the above Report in reference to those parts which inculpate the Metropolitan Commissioners of Sewers, delivered at a Meeting of the Court of Sewers for Westminster, &c.* By the Chairman, THOMAS LEVERTON DONALDSON, Esq.

WE are heartily glad that the subject of the sewers of the metropolis is likely to become an object of inquiry by the administrative authorities, a course for which we have long been anxious. In consequence of a voluminous report by Mr. Chadwick, the secretary of the Poor Law Commissioners, containing many very stringent remarks on the drainage of the metropolis, the ire of many of the functionaries has been excited. It is very evident that there must be something radically wrong in the management, when we find such vast sums of money yearly raised in the metropolis under the name of sewer rates, while the extension of sewage is so very slow. It will be our endeavour to show, without entering upon all the points in dispute, that the present laws and system of building sewers are most oppressive and expensive to builders, and consequently the important system of draining house by sewers is avoided, and instead thereof, cesspools are resorted to, and every scheme which can be thought of to save the expense of building a sewer. Under such circumstances, we are sorry that Mr. Donaldson, for whom we have great respect, should have betrayed himself so far as to become the champion of the present system. The report of Mr. Chadwick, indeed, like the apple of discord, seems to have been productive of much asperity and bitterness of feeling.

Our present object will be to prove that some broad and general measure must be at once adopted for the regulation of the sewage of the metropolis, and that all petty legislation on the subject of drainage should be suspended. We must not have the metropolis split into half a dozen commissions. Now that the subject is fairly opened, we do sincerely hope that the Secretary of State will not listen to the resolution passed at the court of commissioners for Westminster sewers on the 13th ultimo.

"That the Court requests an investigation under the authority of Her Majesty's Secretary of State for the Home Department into the charges brought against the Westminster Commissions of Sewers in the report of the Poor Law Commissioners on the sanitary condition of the poorer classes, and to ascertain the best means of cleansing the streets and roads by aid of sewers, and also the most advantageous form of sewers for the public interests."

This is giving the real matter at issue the go by, we want not the isolated works of the Westminster Commissioners, but what we do want is an examination into all the metropolitan commissioners, to see whether they cannot be advantageously consolidated into one body. We have now on the northern side of the river Thames, the City, the Westminster, the Holborn and Finsbury, the Regent Street, the Tower Hamlets, and the Stebon Heath Commissions; here we have six different commissions, and it is consequently impossible to lay down any one system of drainage for the whole metropolis; for to do so it is requisite to have the consent of all the different commissions, which would require months to obtain, even supposing it possible that they should all agree. We have running right through the very centre of the Westminster sewage, a sewer of a large class, and at considerable depth, constructed about 25 to 30 years since, belonging to the crown, and capable of draining an immense district; yet this sewer cannot be touched by the Westminster Commissioners; then again we have, as Mr. Donaldson tells us, in his report, the Westminster sewers running from the Thames up Tottenham Court Road, to the New Road, then the Holborn and Finsbury Sewage commences, and after the sewer passes through the latter district, it comes to the county drainage, so that any improvement in the drainage of the up-lands of the county could not be made without first, the Westminster Commissioners constructing a new sewer, or lowering an old one, then the Holborn and Finsbury doing the same. So, also, if either commissions wished to divert the upland waters, by constructing catch water drains, so as to prevent too great a flow down any particular district, and prevent the lower parts of the metropolis from being inundated, it cannot be done, and the consequence is, that each commission is obliged to cut about and alter the old sewers, to get rid of the evil in the best way they can.

Mr. Donaldson tells us that

"During the present century, and particularly since the removal of old London Bridge, every opportunity has been taken to lower the outlets. For instance, the Essex Street sewer, between 1816 and 1836, has been lowered from its outfall at the Thames to near Great Russell Street. Bloomsbury, in length 5,800 feet. The eastern branch of the Hartshorn Lane Sewer, between 1831 and 1839, from Long Acre to the New Road, by the line of Tottenham Court Road, &c., in length 4,200 feet. Another branch of the Hartshorn Lane sewer, between 1820 and 1837, from the south end of the Haymarket to Oxford Street, by the line of Princes Street, Wardour Street. &c., in length 3400 feet. The whole of the King Street sewer, between 1830 and 1832, from Westminster Bridge to St. James's Park, 1200 feet. The Wood Street sewer, between 1824 and 1827, the College Street sewer, between 1824 and 1832, and the Romney Row or Horseferry Road sewers, in 1840, have been lowered and rebuilt of enlarged dimensions from their outlets for their whole extent, being a length of 6850 feet, presenting in these lines alone a total of *only* 21,450 feet."

Here, then, we have a fearful summary of expenses incurred in *lowering* the old sewage only, and we think an inquiry might be usefully directed to see if all the commissions had been united, whether it would not have been far cheaper and more effective to run new lines of sewer from the river Thames through districts which had no sewers and to have joined the old sewage at some distant point, and thereby have relieved the old sewers in the lower levels.

By this arrangement, we should have had the old sewers still remaining, which might have answered the purposes of draining either high or low lands, and have obtained an immense additional length of new sewerage at the same expense. We do not mean to say that in all cases under the present system of separate commissions, this could have been effected; but it is a fair subject for enquiry, and can only be got at, by having a thorough examination of all the plans and levels of the present sewerage, in every district, connected with the metropolis.

Mr. Donaldson subsequently calls our attention to the vast works that have been executed for the improvement of the King's Scholar's Pond Sewer; let us give his own words.

"But the greatest work ever executed by this or any other commission has been that effected on the *King's Scholar Pond Sewer*, which has been wholly rebuilt for an extent of upwards of three miles, from the River Side to the Regent's Park within the last 24 years. It has been so vastly deepened and enlarged since the year 1816, that property of the most valuable description, in the neighbourhood of the sewer, at Pimlico, including Buckingham Palace, the lower floors of which are below the highest tide level, and most of the streets adjacent to the sewer between Piccadilly and the Regent's Park, have been benefitted to an incalculable extent. Formerly the whole neighbourhood was inundated by every sudden fall of rain, so that many of the houses in Berkeley Square, Bruton Street, Avery Row, South Molton Street, Wigmore Street, South Street, Baker Street, and Spring Street, were greatly depreciated in value; and some houses in Berkeley Street and Bruton Street remained unoccupied for many months together, in consequence of the well-known fact, that in the summer months those premises were subject to have their lower floors burst up during thunder storms, and the water to rise so as to extinguish the kitchen fires, &c.

"One of the great means for remedying these evils was designed and carried into effect by Mr. Dowley. I especially allude to the entire removal of two immense stone piers, which had at some former time been built in the water way of the sewer, and which piers supported certain parts of the heavy and lofty walls of the houses in Grafton Street, St. George's. These piers, one measuring 53 feet in length, the other of a more square form, whereby the water way was divided into two channels, were formerly considered advantageous to the property lower down the line of sewer, by penning back the torrent of water in times of storms. The work of taking out these obstructions as also removing two great projections, and putting in an inverted arch throughout the whole length of sewer between Hay Hill and Bruton Street, in length 550 feet, at a greatly increased depth, was performed from within-side the sewer, which had its course under buildings. These works proved of such vast importance to the sewage of the district, that what was formerly reported to be impracticable by several eminent engineers, amongst whom were the late Mr. John Rennie, Mr. Jessop, Mr. Chapman, Mr. Bevan of Leighton Buzzard, and others, was actually and substantially carried out, and was afterwards inspected by some of these gentlemen, as also by a numerous committee of the commissioners, who not only approved of the work that had been so done, unseen by any one other than by the workmen employed, but were somewhat surprised that so bold an attempt had been successfully accomplished.

"In the prosecution of the operations necessary for reconstructing *this one line of sewer*, various instances may be cited to show that, at all events, the management and execution were entrusted to an officer of this court who knew something of his profession, and to any one, who is acquainted with that part of the district lying between Piccadilly and Oxford Street, it must be manifest, that cases requiring ability, foresight, science and practical experience frequently arose. I mean such difficult cases as passing a sewer seven feet six inches wide in the clear with side walls two bricks thick, at a depth of 22 feet and upwards, along White Horse Street, Piccadilly, a street only 20 feet wide. Again, carrying the same sewer through Sun Court, Curzon Street, which is less in width than that of the external dimensions of the sewer itself. And, further on, this sewer winds its course under and close to buildings of great magnitude, nearly the whole way from the lower end of Berkeley Square to Oxford Street and in most instances at a depth of from 10 to 12 feet *below the foundations of the contiguous buildings*. Surely, these were works, which, by their nature and extent might be considered of a scientific and high order of civil engineering, and such as have only been approached by some recent works, perhaps, of the city commission of sewers."

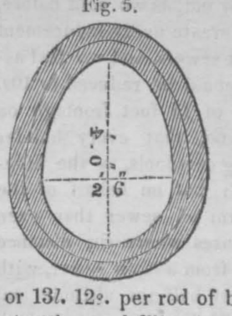
With all due deference to the talents of Mr. Donaldson, we are inclined to doubt the latter part of his statement, that these works "might be considered of a scientific and high order of civil engineering." Instead of enlarging this sewer, and rebuilding it, with all its original sinuosity, the course we should have preferred, would have been to have run a new sewer from where the Scholar's Pond sewer crosses in Oxford Street, near South Molton Street, along Oxford Street, and united it with the Regent Street sewer belonging to the crown. No doubt we shall be told, this could not be done, as the Westminster Commissioners have no power to enter the Regent Street sewer, this then would at once have proved the great necessity of uniting the several commissions; now, if this plan could have been adopted, it would have relieved the large pressure of water flowing down the sewer, and inundating the houses as represented in Mr. Donaldson's report, and would have saved the great expense incurred in removing the large piers under the houses in Grafton Street, and rebuilding the tortuous part of the sewer in the vicinity of Curzon Street; and another advantage gained, would have been in giving Oxford Street a sewer, which had none. Similar relief might have been given to other portions of the large sewers which were overpowered with the upland water, and new sewers given to such portions as had none before; for instance, another sewer might have been constructed, to have commenced about Berkeley Street, and run along Piccadilly, and discharged itself into the Regent Street sewer, near the Quadrant, connecting with it the sewers of the side streets, which would have relived the Scholar's Pond Sewer and have given Piccadilly a sewer which it was deficient of until lately. And again, the sewer of Pall Mall might have been diverted into the Regent Street sewer, although it comes to within a few yards of it the sewage is carried into the Scholar's Pond Sewer, and has to travel a distance of a mile and a half before it discharges itself into the Thames, whereas, if the former plan had been adopted, the discharge into the Thames would have been within half a mile. If these collateral sewers had been built, the vast sums of money in reconstructing a considerable portion of the Scholar's Pond Sewer, and building the large approaches described in Mr. Donaldson's address, might have been saved and part of the cost devoted to the new sewers we have described. We think that we could point out several other improvements that might have been adopted, if the commissions had been united; but we have already trespassed beyond our original intention upon this portion of the subject, and must now turn our attention to the more important part respecting the form, construction, and expense of the present sewers of the Westminster Holborn, and Finsbury, and Regent Street commissions.

We will first proceed to enquire into the present cost of constructing sewers, and see how far they might be modified, so as to induce builders of small tenements to construct sewers, in preference to cespools; in order to do this, we are at once brought to another bone of contention between the present combatants; one commission contends that the oval sewer is the best form, whilst another flatly contradicts it, and says that sewers with upright sides are the best; we must therefore first hear what Mr. Donaldson says upon the subject.

"With respect to the form of section of sewers, our commissioners have very wisely adhered to that, which experience has proved to them to be substantial and best calculated for the purpose. We are to recollect that under-ground constructions must be built so as to last for ages, otherwise a continued re-building of sewers causes a constant breaking up of the streets, and obstructions to thoroughfares, and a suspension to a certain degree of the commerce of the trades-people on the line. The sewers must be large enough not merely for the ordinary service of relieving soil drainage, but also for carrying off the torrents of water, which fall during violent storms. Hence a large capacity must be given them. Again, this large dimension is not without a further use in enabling the officers and workman to inspect and repair them with sufficient facility, the width even of our second sized sewers enabling two workmen to pass each other. As regards the upward sides of the sewer, it must be borne in mind that all circular work constructed of brick can only be formed by making the joints more open at the extrados than at the intrados, for the square shape of the brick does not lend itself to other than rectangular construction. Now these open joints are filled with mortar in a moist state, and before it is set, the earth to the depth of several feet is filled in, the centres are struck, and the consequence is an irregular settlement of the whole work; whereas with spreading footings, an invert at bottom, a circular arch at top, and upright side walls, most of these inconveniences are avoided, and the sewer, even if the earth be washed away at the top or sides, as sometimes happens from the bursting of one of the large main pipes of the water companies, stands upright and alone on its board base, whereas the oval sewer must have inevitably fallen over. I may also add two other important reasons for giving as much square construction as possible to the body of the sewer, and these are, greater security against imperfect workmanship, and detection of false thicknesses of work at sides. Besides, in the event of its being judged expedient to increase the depth of a sewer by putting in a new bottom by underpinning, this operation becomes comparatively easy with upright side walls—almost impracticable when they are curved. Much stress is laid in the report upon the curved side walls as materially aiding the rapidity of the current. But, in fact, the ordinary sewage *rarely rises above the invert*, and when it does, there is such a force in the volume of water, that no perceptible obstruction is offered by the absence of the complete circular form."

If, on comparing the sewers of the Westminster Commissioners, Fig.1 and 2, with those of the Holborn and Finsbury Commissioners, Fig. 2 and 3, it must be seen that Mr. Donaldson's remarks about circular work are completely futile, for his objections apply equally to the arch and invert of the Westminster as they do to the Holborn and Finsbury; and as to the sides, the radiating of the courses in the oval form is so trifling, that it is not worth naming. And again, can Mr. Donaldson tell us if such an accident ever occurred, as the bursting of a main pipe, and of washing away the earth to the extent of endangering an oval sewer. We have frequently heard, that during the construction of the upright sewers, of their falling in [1], but never heard of such a case with the oval sewer. 20 years ago, we happen to have been engaged in the construction of about 1000 feet of sewage of the oval form, as shown in Fig. 5, built upon the crown lands in the vicinity of Regent's Park, and up to the present time we have never heard of a single failure, either during the construction or since; we think this fully justifies us in pronouncing that the oval form is most effective, and in point of expense infinitely to be preferred. Now let us compare the expense of both forms, we will take the cost of the materials and labour the same in both cases, 1s. per foot reduced, or 13*l*. 12*s*. per rod of brickwork, and 1s. per cubic yard for digging, strutting, and filling in or removing the surplus ground, the top of the sewer being taken as 6 feet below the surface of the ground.

Fig. 5.



Westminster Sewers.

Fig. 1, first class.

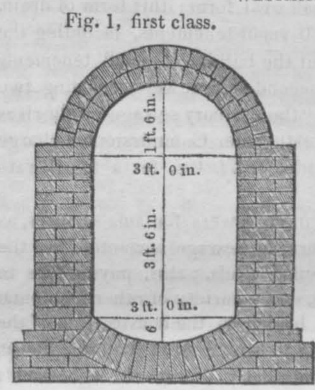
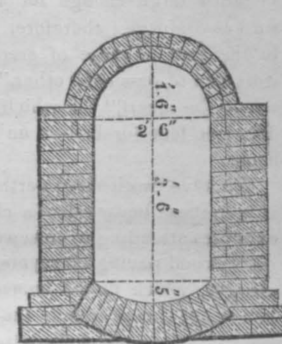


Fig. 2, second class.



	s.	d.
17 feet brickwork - -	17	0
3⅓ yards digging - -	3	4
	20	4

	s.	d.
15 feet brickwork - -	15	0
3 yards digging - -	3	0
	18	0

Holborn and Finsbury Sewers.

Fig. 3, first class.

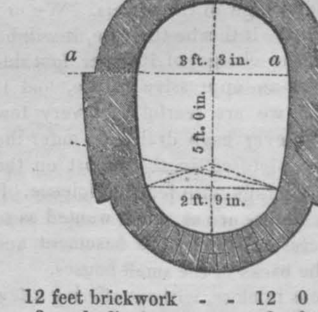
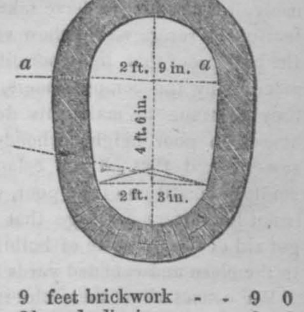


Fig. 4, second class.



12 feet brickwork - -	12	0
3 yards digging - -	3	0
	15	0

9 feet brickwork - -	9	0
2⅓ yards digging - -	2	4
	11	4

Fig. 5,[2] the Regent Commission sewer is built in two half brick rims, and contains about the same quantity of brickwork as fig. 4, and may be taken at the same cost. Thus it will be seen that in adopting the oval form, there is a saving of 5*s*. 4*d*. per ft. in the first-class sewer, and 6*s*. 8*d*. per foot in the second-class sewer. Can there then be, after perusing the above calculations, a doubt as to which form of

[1] We could find several cases of the Westminster sewers falling in during their construction, and the upright sides bulging in, as at Notting Hill, and also in the vicinity of the King's Road, Chelsea. But we are told by th worthy chairman, that they were built by private individuals, and not by the commission. Let us ask Mr. Donaldson. under whose direction and superntendance are they built? Dare a builder alter the form, or lay a brick contrary to the directions of the commissioners' surveyor; if this be the case, the commissioners are responsible for the work and the form of the sewer, and not the builder.

[2] We give the preference to the oval sewer, Fig. 5, over that of Fig. 4, as the larger part of the oval is downwards, which allows a greater flow of water to pass off quicker; we also consider that the extra half-brick thickness of the sides of Fig. 3, oval sewer, perfectly useless, and might with safety be omitted, which would reduce the cost of the sewer, 1*s*. 8*d*. per foot.

sewer the preference ought to be given? then why oppress the builder by compelling him to construct such expensive sewers as the Westminster Commissioners require? Why not, as we said before, give some encouragement? Nay, we would create every inducement to the builder of small tenements to construct sewers, and we feel assured that if the expense of building sewers could be reduced to 10*s*. per foot, making the charge for small houses of 15 feet frontage on *each side* of the sewer under FOUR POUNDS, that every builder would adopt sewers in preference to building cesspools, as the difference in expense would then be so trifling; but on behalf of the builder, we contend for a still smaller form of sewer than even the second size oval sewer, for in many cases where the distance required to be drained is not above 200 feet from a main sewer, with a good fall, we would allow an oval drain of half the altitude and breadth of fig. 5, to be constructed with a half-brick rim, or an 18 inch barrel drain, with manholes every 50 feet; the expense of such drains would be 2*l*. 5*s*. for houses on each side of the drain for the 18 inch barrel drain, and 1*l*. 10*s*. for the small oval form; this form of drain, is amply large enough for 25 to 30 small tenements, including the surface drainage; therefore, why put the builder of small tenements to the vast expense of erecting "second-size sewers, enabling two workmen to pass each other," when "the ordinary sewage rarely rises above the invert," for which the Westminster Commissioners charge 10*s*. per foot for houses on each side, or 7*l*. 10*s*. for a fourth-rate house.

We have dwelt more particularly upon sewers for small houses, as it is to these houses that a cheap form of sewage is wanted, for the expenses attending upon sewers, forming roads, paths, paying fees to district and paving surveyors, leases, and a variety of other incidental charges, which do not immediately belong to the construction of the house, fall almost equally the same on the small as on the large house, and raise the cost of the latter so enormously, that much higher rents are obliged to be obtained from the small tradesmen and operatives than would otherwise be required if these charges could be reduced. We could give an instance at the present moment, where parties who have built some fourth-rate houses immediately contiguous to a main sewer of the Westminster Commision, will not incur the expense of the sewage by paying 10*s*. per foot, but prefer constructing cesspools.

It will be a question well worthy of inquiry to ascertain what number of houses there are on each side of any of the sewers that have been built or rebuilt by the Westminster Commission, and see how many of those houses have taken advantage of the sewers. We are fearful the return would show very few. If this be the case, it will be the best proof that the enormity of the charge of 10*s*. per foot demanded by the commissioners, is of an oppressive nature, and if they continue to make this demand, we are fearful that very few houses in poor neighbourhoods will ever have drains to enter the sewers, and that all the calamities pictured in the report on the sanitary condition of the poor, will still rage with fearful violence. It is not for surface drainage that new sewers are so much wanted as to get rid of the nuisance of building cesspools under the basement, and in the close and confined yards at the backs of the small houses.

We cannot allow these observations to close, without offering a few remarks on the regulation for constructing drains. We believe all the Commissions compel each house to have separate drains, no matter how far the house may be from the centre of the sewer. We recollect, a few years since, seeing the ground opened to the distance of at least 60 feet long, and 10 feet deep, opposite to every house in the Grand Junction Road, Paddington. Now, if the commissioners would have allowed a 15-inch drain to have been constructed from the sewer for every three houses opposite the centre house, with a branch drain, nine inches clear, at the end next the houses, there would have been a saving of 100 feet run of digging and making good roads, and a drainage equally as effective, if not more so; for it is not so likely that the single 15 inch drain would have got choked as the three 9 inch drains. And again, why not allow a 12 inch drain to be constructed opposite the party wall, between two houses, for the drainage of the two, some compulsory law might be made for compelling both owners, if there should be two, to contribnte their share to the repair or cleansing the drain, if it were required. By some modification of this nature, a vast expense would be saved both to builders and owners of houses, as the principal expense in carrying a drain into the sewer is generally the opening of the ground and making good the roadway.

We have, in the present notice carefully abstained from entering into an examination of the Flushing apparatus, the feasibility of cleansing the streets by means of the sewers, and also the consideration of uniting the paving of the metropolis with the sewers under one commission, the same as is now done in the City of London, for all these points require to be gone into at considerable length at some future opportunity. We hope we have been successful in establishing that sewers may be constructed far more economically, and equally as effective, as the present form of the Westminster sewers, and that considerable improvements might have been adopted in rebuilding and relieving the old sewage, and at the same time increased to a large extent the sewage, without any additional expense, and if we have done so, satisfactorily, it then behoves us to press upou the government to take up the inquiry on a broad scale, employ competent parties to report upon the subject, and see how far a grand measure might be laid down for the improvement of the whole of the first metropolis in the world.

CONCRETE, ITS INTRODUCTION, COMPOSITION, USES, AND COMPARATIVE EXPENSE.

CONCRETE was first used in this country by Sir Robert Smirke, at the erection of the Penitentiary at Millbank, afterwards at the undersetting of the walls of the New Custom House, and has been generally used by the above named architect in the public buildings since erected under his care, especially at the club house of the Oxford and Cambridge University in Pall Mall, where the whole area of the building, and to the extent of two feet beyond the line of the lowest footing, was covered to a depth of 2½ feet, the depth being increased to 4 feet under all the walls that rise to the roof; in the specification of the last named building it is thus described. "For the grouted stratum clean river gravel is to be provided, and mixed with lime ground or pounded to a fine powder; it is to be well mixed with the gravel, twice turned over before it is wheeled to the excavation, and it is to be thrown from a height of not less than 6 feet in every part. A man to be kept treading down and puddling the mass as it is thrown down; the proportion of materials to be 6 parts of gravel to one of Dorking, Merstham, or Haling stone lime." It has now become, in the present day, the most favourable expedient resorted to for artificial foundations. Mr. Ranger, of Brighton, improved the above hint by using hot water to facilitate the setting, for which he took out a patent for making artificial stone. A detailed account of the application of Mr. Ranger's artificial stone to the building of docks and river walls at Chatham and Woolwich, is given in the 1st vol. of the *Journal*, being a paper by Lieut. Denison, from the Papers of the Corps of Royal Engineers. Analogous to concrete is beton, from which it differs, in broken stone being used instead of gravel, in the proportion of two of stone to one of lime or pozzolana of Italy, a description of which, taken from the *Franklin Journal*, appeared in Vol. 3, page 265, of your valuable periodical. Since the introduction of concrete, some little difference of opinion as to the proportions of materials and manner of mixing them has arisen among engineers. I therefore give the composition from several specifications:—No. 1. The concrete to consist of 5 parts of clean gravel, perfectly freed from loam or clay, with a proper proportion of small gravel and sand, as well as large, and one part of lime measured dry, the lime to be mixed into a perfectly smooth uniform paste, as for the mortar, but with more water, and then thoroughly mixed with the gravel.—No. 2. The concrete to be composed of sandy gravel and well burnt lime, in the proportion of 3 of the former to 1 of the latter. The gravel to be free from all earthy matter, and the pebbles not to exceed one inch in diameter.

The lime is to be used in a hot state when slacked, and to be immediately mixed, using no more water than is sufficient to incorporate them. After being twice turned, it is to be wheeled on to a stage 10 feet high, and let fall into the trench; it is not to be puddled or disturbed in any way until perfectly set.—No. 3. All concrete must be composed of gravel perfectly clean, and mixed with fresh well-burnt lime in the proportion of 6 of gravel to 1 of lime. The lime and gravel to be mixed in a dry state, and a sufficient quantity of water afterwards added.—No. 4. Concrete to be composed of good lime, gravel, and sand, in the proportion of $\frac{1}{7}$ to $\frac{1}{9}$ of lime, and it should be laid in about 12 inch layers or courses, and pitched from a height of 10 to 12 feet, neither should it be disturbed until properly concreted and set.

In the above five opinions, including that of Sir Robert Smirke, we have the relative proportions of gravel and lime, varying from 3 to 9; and No. 1 states the lime and water to be first mixed, in which No. 2 nearly coincides, whilst No. 3 insists on the gravel and lime being first mixed, and then the water added; Nos. 4 and 2 coincide that the concrete is not to be disturbed after it is thrown into the trench, whilst Sir Robert Smirke expressly states that parties are to be employed puddling the mass. The whole are agreed in specifying that the material is to be thrown from a height. From considerable practice and experience in the mixing of concrete, I think that the lime need not be ground, but simply mixed with the gravel, and then, by the addition of water, it will fall to an impalpable powder, also that it is unnecessary to be at the expense of puddling the mass after being deposited in the trenches, neither is there any advantage to be derived from discharging the mixture from a height, both of which operations increase the expense of the concrete, and as the concrete in the act of setting expands in bulk, I think that alone a sufficient proof of the inutility of both of the above mentioned operations, their tendency being to condense the mass, whilst its own natural tendency is to expand. With respect to the proportion of lime and gravel, I think the less lime the better will be the concrete, and that the proportion of 8 to 1 of lime is decidedly better than 3 of gravel to 1 of lime. As to the quality of materials employed, the lime must be stone lime, fresh from the kiln; that from chalk will not do, and hydraulic or lias lime is to be preferred to stone limes. With respect to gravel, if obtained from a pit, the ochereous or ferruginous is to be preferred, and if loam is present, so as to soil the hand, the gravel must be washed, if the gravel be obtained from rivers by dredging, alluvial and vegetable deposits are to be avoided; and if the gravel contain vegetable refuse, it must be screened or washed. Shelly sharp gravel is the best, the proportion of small or large pebbles, and the due quantity of sand, is soon learned with a little practice.

As to the uses of concrete, it is principally adopted as an artificial foundation, and from four to six feet is a sufficient depth, and extending two feet beyond the space to be occupied with the building. The following testimony of the utility of concrete, is from Weale's Bridges, page 31. "Piling will probably never be found more safe than a body of concrete; the latter cannot be too much esteemed, for its durable and almost imperishable nature, besides being quite as safe and, perhaps, more durable than piling;" and from the paper of Lieutenant Denison, before alluded to, we have the following ratification of its uses. "Concrete cannot be advantageously employed as a building material." "It may be employed with advantage in backing retaining walls." I. K. Brunel, Esq., C. E., has used concrete as a foundation, nearly exclusively and universally in the bridges on the Great Western Railway; and in the celebrated bridge of Maidenhead, the land arches are backed with concrete, to the depth of 10½ feet, and the abutments of the large arches are also backed with concrete. In culverts underneath embankments, the same able engineer has extensively used concrete as a backing material, the brickwork being kept thin, and then enveloped in a mass of concrete, in the form of a polygon, of six sides, or, of the form of two truncated cones, with their bases joined.

Concrete was used on the Great Western Railway, wherever it could be employed, as a backing material; its use is now rapidly extending to the provinces, and bids fair to supersede all other means now employed for making a foundation; it is much improved by being mixed with oxide of iron, smith's scales, and roasted iron stone, or any material containing iron. As regards the comparative expense, brickwork being the most common building material, has been taken as the standard of comparison with concrete for price, and its cost in most districts will be found from one-third to one-sixth the price of brickwork, taking a cubic yard as the quantity of each material, the latter will cost 5*s.* and the former 21*s*, both, to a great extent, being regulated by the vicinity of brickyards, and the facility of obtaining gravel. I have known concrete executed at 3*s.* 3*d.*, 3*s.* 6*d.*, 4*s.*, 4*s.* 6*d.*, 5*s.*, 7*s.* 6*d.*, 8*s.* 6*d.*, and 11*s.* 6*d.* per cubic yard, although the most common price is 7*s.* 6*d.*; as to brickwork, the general price is 21*s.*, and the range is from 14*s.* to 27*s.* 6*d.* per cubic yard. The London price being 25*s.* per cent. dearer than the country. The facility of obtaining lime regulates the cost of concrete; the price of lime per cubic yard, measured dry in clots, at Dorking in Surrey, is 11*s.*; Barrow in Leicestershire 21*s.*; Bulwell in Nottinghamshire 9*s.* 6*d.*; Breadon in Derbyshire 15*s.* 6*d*; Harefield in Buckinghamshire 16*s.* 6*d.*; Fulwell, Durham County 9*s*. The measures of lime, also, vary much; in some places it is sold by the cubic yard, measured dry, which is decidedly the best method adopted; it would be desirable if it was universal. It used to be sold in London by the hundred, as it was called, not of weight, but a measure, a yard square, and a yard and one inch deep, which will be equal to 16 or 18 bushels, but it is now sold by the cubic yard. The Fulwell and Barrow lime is sold by the quarter, eight of which make a ton and a half. Lime is also sold by the boll and chaldron; a chaldron will be about 3½ tons, a single horse cart about six bolls. In agricultural districts, the bushel, boll and quarter are used; in colliery districts, the chaldron and ton are the standard of measure. With respect to the cost of gravel, provided it can be obtained on ground belonging to the company, the getting, screening, and cartage will cost 1*s.* 6*d.* to 2*s.* per cubic yard; if it be obtained from the gravel pits of the country, the charge will be per ton, from 2*s.* 6*d.* to 2*s.* 9*d.*, if screened 3*s.* 3*d.* to 3*s.* 10*d.*, if broken 6*s.* 10*d.* A cubic yard will weigh from 24 to 27 cwt. If the gravel is dredged or brought from the shores of a river, the cost will be 2*s.* 6*d.* per yard, or nearly the same as from the pit. The prices of the various operations of getting, screening, and washing gravel are respectively 10*d.* and 12*d.* per cubic yard. The price of excavation is also included in the price of concrete in all railway specifications, which will be about 4*d.* per cubic yard, as generally the excavation is of limited extent, and consequently more expensive than an extensive excavation, and when the gravel is obtained on the ground of the Company or proprietor, the excavation is a double operation, the hole having to be refilled with other materials in lieu of the gravel obtained. From the experience of several thousands of yards and variety of situations, I find the cost of mixing the materials, or as it is termed concreting, to be 1*s.* per cubic yard, and taking the proportion of material at 5 to 1, the following will be a fair estimate of the cost of concrete:—

		s.	d.
1 cubic yard of lime	-	12	6
5 do of Gravel at 2*s.* 6*d.*	-	12	6
Labour mixing at 1*s.* per yard	-	6	0
6 yards of excavation at 4*d.*	-	2	0
Waste, contingencies and profit, at 1*s.*		6	0
6 cubic yards, at 6*s.* 6*d.*	- =	39	0

Concrete will set in 24 hours; the specific gravity is 125, or about the same as brickwork, although brickwork is sometimes 165 lb. per cubic foot. Lieutenant Denison gives the strength of concrete $S = \frac{lW}{4bd^2}$ The constant S being 9·5, and comparing concrete to York paving, the proportion is as 1 to 13.

The following works may be consulted; Colonel Pasley, on Calcareous Cement: Weale, 1839;—Aikin on ditto, in Transactions of Society of Society of Arts;—Lieutenant Denison's Notes on Concrete, from papers of Corps of Royal Engineers, *Journal*, Vol. 1, p. 380; Lieutenant-Colonel Reid, ditto, see also the *Journal*, Vol. 1, page 134; a letter on concrete, by a Constant Reader, Vol. 3, page 265, Vol. 5, pages 58, 276.

I am, &c.,

St. Ann's, Newcastle-upon-Tyne. O. T.

WIRE ROPE LIGHTNING CONDUCTORS.

Sir—Having seen, in some of the recent numbers of the *Mechanics' Magazine*, a long discussion as to the priority of claim, respecting the wire rope as a substitute for metal rods, in conductors, I beg to call your attention to a paragraph, which appeared in a work, published by Sir John Herschel, more than 10 years ago. He says thus; that wire rope has long been used at Munich in preference to metallic rods, for lightning conductors. I think this proves that the subject has been long tried and practised, before Mr. M. J. Roberts brought forward the subject.

Your insertion of this will oblige

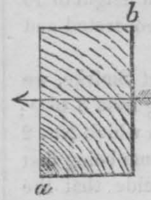
A Subscriber.

WROUGHT IRON AXLES.

Sir—It is worthy of remark how slowly well proved facts, individually acknowledged and acted upon, become generally admitted; it is to be regretted that we are not more communicative of those events which strike us in our daily practice, and which, if announced as soon as discovered, would so materially and rapidly tend to general improvement. There is, perhaps, no instance in which this can be more clearly exemplified than in the use of wrought iron; it is scarcely possible to refer to the subject without an example being readily laid before you. Every manufacturer has had more or less his attention drawn to the fact, that in its various applications wrought iron is subject to become brittle. Iron spindles, piston rods, fire bars, crow bars, chisels, and many other things, are known to lose their fibrous quality after being in use for a length of time, varying according to the nature of the service they have had to perform. By some it has been considered that the iron originally employed was of bad quality, and the circumstance when discovered has not been otherwise attended to than by replacing the broken piece; but in many instances the phenomena has been clearly established, closely examined, and well attended to, and that for years together, without, however, having become a generally acknowledged fact, sufficiently positive to justify the opinion that wrought iron, applied for certain purposes ought only to be allowed to perform a previously determined quantity of work, after which it becomes requisite to re-forge the piece.

In most cases the fracture may be unattended with danger to human life, but in others, as in connexion with railways, where hundreds of lives may depend on the strength of an axle, it daily becomes more evident that extraordinary precautions must be resorted to for the purpose of avoiding accidents, and I would, with regard to railway axles, suggest (as a precautionary measure) the propriety of limiting the distance they should be allowed to run previous to their being thrown out as unfit for service, and that whether apparently in good condition or not. Such is the perfection with which these axles can now be manufactured, that when a suitable quantity of iron is used, it may be confidently asserted that every axle turned ont of the shop after due examination may be considered to be sound, and that by limiting the work it is allowed to perform, the fracture of an axle would become a very improbable event.

Having been lately in Paris, I mentioned the circumstance to M. Arnoux, the directing manager of the extensive works belonging to the Messageries Laffite & Caillard, persuaded that from a person whose attention has been for so many years engaged on this subject, I should obtain some positive information; he showed me a number of axles which he had caused to be broken, after they had performed their allotted quantity of work; they all broke short and brittle, the fracture invariably indicating the progress of the disease. The fracture commences at the lower angle of the axle on the side of the traction, which is evidently in fixed axles the point of greatest fatigue, and in those axles which have given way under the weight of the load, the fissure has in some instances nearly traversed the axle before it broke entirely, and it is then very easy to trace the accident from its engine. I will endeavour to describe its usual appearance by the following diagram; the arrow shows the direction in which the carriage moves.



The fracture invariably originates at the angle *a*, and appears to progress at intervals by zones as shown by the lines in the diagrams, the first, at the point *a* becoming perfectly black, the colour of each being lighter as they gradually extend from this point, and as the contact of the two sides of the fracture becomes more intimate, the grain of the iron towards the angle *a* is coarse, and has a large crystalline texture, which diminishes in size as the fracture approaches the angle *b*, at which point the metal remains slightly fibrous, having evidently undergone a more rapid deterioration at its point of greatest strain.

M. Arnoux informed me, that in consequence of this effect, to which he has for a long time paid great attention, he has come to the conclusion that an axle can only safely run a distance of 30,000 leagues, or about 75,000 English miles; when an axle has run that distance, he invariably takes it out, places it between two new bars of iron, and welds them together so as to form a new axle. If the carriage usually runs over a paved road, such as is frequently met with in France, the axle is not allowed to run so great a distance, and a certain degree of wear in the collar then determines the period at which the axle is thrown out, not in consequence of the wear of the collar, but because that degree of wear has proved, by experience, that it is prudent to renew the axles in order to avoid a fracture.

Here, then, we have the proof of an important principle in the application of wrought iron, being well established and long known to one, and probably to many individually, without having come to the knowledge of railway engineers, who are thus compelled to arrive at this important truth by dint of actual experience, obtained through the medium of a series of lamentable accdents, and they could not acquire their information in any other way, unless made acquainted with the circumstance by those who have previously purchased their knowledge.

The question, then, admitting the above statement to be correct, will be, how great a distance it may be pruden: to allow railway axles of different descriptions to run; and to solve this question, it will be advisable, in the first instance, to adopt a term which may certainly be within the limit of perfect safety, until the greatest distance that can be safely adopted may have been determined by a series of well conducted experiments.

Iron exposed to great heat undergoes the same kind of deterioration. I examined, in the same establishment, several bars taken from a furnace in which they heat their wheel hoops; the part of the bar directly exposed to the fire offered the same crystalline appearance as the broken axles, which gradually diminished towards the end that was out of the fire, and the end of the bar which was out of the fire altogether, had the appearance of good tough iron. The portion which had suffered most from its direct contact with the heat, having been doubled over and welded entirely, recovered its fibrous quality, and stood a cold bend as well as any iron that had not been in the fire.

Should you find this communication worthy a place in the *Journal*, you will oblige, by its insertion,

Your obedient servant,

20th January, 1843. H. H. Edwards.

SELF-REGULATING EXPANSION SLIDE VALVE.

Fig. 1.

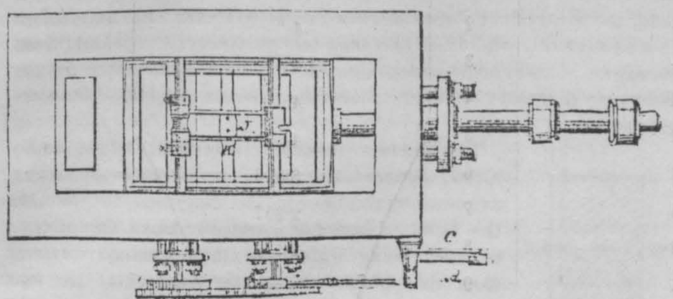


Fig. 2.

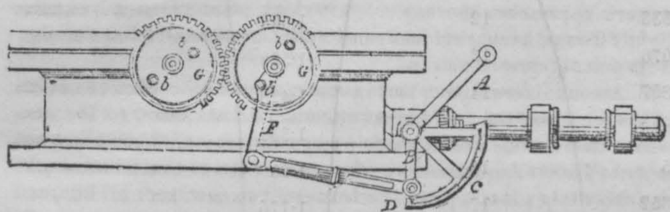
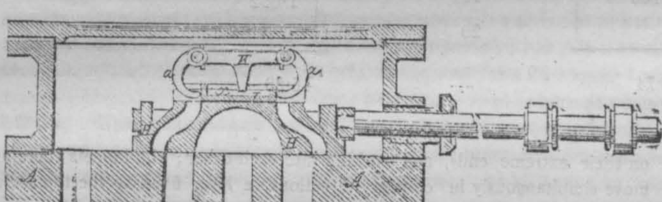


Fig. 3.



IMPROVEMENT in the steam engine is so much sought after, so many are engaged in the pursuit, and economy in the consumption of fuel is a question of so much importance, that no apology need be offered on presenting a plan to attain that object, and which has been found here or elsewhere to be an absolute improvement.

The simple apparatus which I am about to describe, (for which I obtained two patents abroad,) has been applied very successfully, and is now getting into extensive use. I believe it to be unknown in this country, except to a few persons to whom I have explained it; and as it will on most occasions be found to be useful, I propose to make it known through the medium of your truly valuable columns, which being open to communications of the kind, and much read, I should be happy to introduce this to your readers through so respectable a channel.

The advantage of using steam expansively does not require demonstration, it is too universally acknowledged to admit of any doubt; I must, however, enter a little into the subject, to point out the benefit to be derived from the application of my slide valve, but will endeavour to be as concise as possible.

An engine working without expansion, receives the steam on its piston during the whole length of stroke, its speed being regulated by contracting more or less the passage through the throttle valve, thereby to a certain extent wire-drawing the steam. The speed of the engine is effectually regulated by this means, but a considerable quantity of steam is thereby thrown away, as I will endeavour to show.

It frequently happens that an engine is lightly loaded, and as the loss to which I allude is comparatively greater with a light load than with a full one, on account of the wire-drawing becoming more complete, I will take for example an engine working with such a load as will require the orifice through the throttle valve to be sensibly contracted, in order to keep down the speed of the piston.

When the engine passes over her centre, the motion of the piston is very slow, and the orifice of the throttle valve will allow the steam to rush into the cylinder in sufficient quantity to exert its full pressure; but as the speed of the piston increases, the quantity of steam admitted becomes insufficient to fill the space at full pressure behind the piston.

The piston continues increasing in speed until it reaches the middle of the cylinder, where it is the greatest, from that point to the end of the stroke the speed decreases until the motion is reversed; there is necessarily a point of the stroke at which the speed is so slow, that the quantity of steam admitted through the throttle valve will be proportionate to the speed of the piston, and from that point until the end of the stroke, as the speed of the piston decreases, the steam will accumulate in the cylinder, and the pressure will increase; but at that moment the position of the leverage of the crank is such, that the increasing pressure of the steam produces comparatively little effect on the speed of the engine, and at the moment at which the pressure reaches its maximum, the slide valve is reversed, and the contents of the cylinder are thrown into the condenser.

The quantity of steam thrown into the cylinder at the beginning of the stroke is not lost, because it continues to act expansively on the piston, and becomes a portion of that volume of steam which determines the speed of the engine and the relative steam passage through the throttle valve; but as I said above, the volume of steam thrown in towards the end of the stroke, only serves to fill the cylinder uselessly at the moment when its contents are about to be thrown into the condenser.

If the engine happens to have a light fly-wheel, the evil is considerably increased, because the speed of the engine will sensibly decrease towards the end of the stroke, the orifice of the throttle valve will be enlarged by the action of the governor, and an increased volume of steam will be admitted into the cylinder just in time to be thrown away.

By working the steam expansively, the above-mentioned loss is avoided; and if the resistance to be overcome was constant—as for instance, to raise a given quantity of water to a given height in a given time—then the fixed expansion would answer every purpose; and this is, perhaps, the only instance in which that can be said to be the case.

Generally speaking, the load is variable, and when that is the case, the point of the stroke at which the steam is cut off should also be variable, so that the steam employed should exert its full pressure while it is being admitted to the piston, in order to produce the full effect of expansion from the moment it is cut off until the end of the stroke.

For this to be carried out efficiently, the engine itself must determine the point of the stroke at which the steam should be cut off, and the governor is sufficient for the purpose. I think I may infer, that the valve hereafter described, will be found useful *for all engines which require a governor to regulate their motion.*

The present system of advancing the eccentric, and constructing the working valve, so that the steam is cut off at about three fourths of the stroke, is an immense improvement, but stops short of what is wanted, particularly for those engines which work with high steam.

The elasticity of steam being subject to the same law that governs the elasticity of atmospheric air, as determined by Mariotte, the elasticity being proportionate to its density, then a volume equal to 200 under a pressure = 2, will be reduced to 100 under a pressure = 4, and will expand so as to represent 400, the pressure being reduced to = 1.

This being the case, let us suppose the length of the stroke of the cylinder of a steam engine divided into 20 equal parts, and that steam of four atmospheres is acting upon the piston during the whole of the stroke; the consumption of steam will be represented by $20 \times 4 = 80$, and the sum of the forces will also be $20 \times 4 = 80$; in this case the consumption of steam will be as 1, and the power exerted will also be 1.

Take the same cylinder, and admit steam of the same pressure during $\frac{15}{20} = \frac{3}{4}$ of the length of stroke, the quantity of steam expended will be $15 \times 4 = 60$, and the sum of the forces will be $15 \times 4 = 60$ for the first 15 spaces, and 16·77 for the remaining 5.

The consumption of steam will be 60 = 1.

The power exerted will be $60 + 16{\cdot}77 = 76{\cdot}77 = 1{\cdot}27$.

(See diagram No. 1.)

Again, in the same cylinder, admit the steam only during $\frac{10}{20} = \frac{1}{2}$ the length of stroke, the quantity of steam used will be $10 \times 4 = 40$, and the sum of the forces will be $10 \times 4 = 40$ for the first 10 spaces, and for the remaining 10 spaces it will be 26·75.

The consumption of steam in this case will be 40 = 1.

The power exerted will be $40 + 26{\cdot}75 = 66{\cdot}75 = 1{\cdot}66$.

(See diagram No. 2.)

	No. 1.	No. 2.	No. 3.
0	0	0	0
1	4	4	4
2	4	4	4
3	4	4	4
4	4	4	4
5	4	4	4
6	4	4	3·333
7	4	4	2·857
8	4	4	2·5
9	4	4	2·222
10	4	4	2·
11	4	3·636	1·818
12	4	3·333	1·666
13	4	3·076	1·538
14	4	2·857	1·428
15	3·75	2·666	1·333
16	3·52	2·5	1·25
17	3·34	2·352	1·176
18	3·17	2·222	1·111
19	3·	2·105	1·052
20	6·78	2·	1·
	46·28	66·74	46·28

Carry this again further out, by admitting the steam only during $\frac{5}{20}$ = ¼ of the stroke, and we shall find for the expenditure of steam 5 × 4 = 20, and the sum of the forces for the first five spaces will be 5 × 4 = 20, and for the remaining 15 it will be 26·28.

The consumption of steam in this case will be 20 = 1.

The power exerted will be 20 + 26·28 = 46·28 = 2·31.

(See diagram No. 3.)

To obtain the greatest possible advantage from steam it is requisite:

1st. To employ it expansively.

2nd. To admit it into the cylinder at its full pressure without being wire-drawn.

3rd. That the portion of the stroke during which it is admitted freely, should be determined by the engine governor.

The construction of this self-acting slide expansion valve, will be understood by inspection of Figs. 1, 2:

A, being the face of the cylinder.

H, the slide valve, acting exactly the same as the ordinary slide valve.

I, a moveable metallic plate, worked by friction against the back of the slide valve H, as far each way as will be permitted by the cam or tappet *a*, the position of which will be determined by the governor.

When the points of the tappets are approached so as to hold the plate I, the slide valve H, alone will move, and the steam will act only during a very small portion of the stroke of the piston.

When the points of the tappets separate, the plate I, will be carried along with the valve, until brought in contact with the tappets, and the greater the distance between the points of the tappets, the longer the steam will be admitted into the cylinder.

When the tappets are sufficiently thrown back to prevent the plate I, from reaching them during the whole length of the stroke of the valve, the fixed bracket K, will then place the plate I in the middle of the slide valve, and the steam will be admitted during the whole length of stroke of the piston, with the exception of what portion may be cut off by the advance of the eccentric.

The two spindles which carry the tappets *a*, pass through stuffing boxes reserved on one side of the valve box, and are turned by two sectors fixed on their extreme ends, and working into each other; the tappets therefore move simultaneously in contrary directions, a lever fixed to the top sector being worked by the governor, so as to separate the points of the tappets *a*, as the speed of the engine diminishes, and to approach them nearer together as the speed increases, and in this way steam will be admitted in such volumes into the cylinder, as will effectually regulate the speed of the engine without ever contracting the orifice of the throttle valve.

This summary explanation is quite sufficient to show the principle upon which this valve is constructed, and by what means the purpose is effected; what follows, is a somewhat more detailed account of the same, useful only as entering a little more minutely upon the subject, and giving some instructions to be attended to in its construction.

To facilitate the setting of the metallic plate I, attention must be paid to the position of the tappets *a*, because upon their position depends the proper effect of the valve. The upper sector G, is keyed on the end of the spindle, and the lever F, is fixed to the sector by two screws *b*, running through oval holes in the sector, which permit the spindle to be turned a little either way, so as to move the points of the upper tappets a little nearer to, or a little further from the plate I.

On the lower spindle the same facility is obtained, by keying a plate on the spindle, instead of fixing the sector itself, and then by fixing the sector to the plate by two screws, giving play in the holes as above, the bottom tappets can also be varied as may be required.

To cause the plate I to adhere to and follow the vale H, in its motion, a spring K, is fixed on the back of the plate I, and the two ends of the spring slide in a groove, formed by two side pieces fixed to the slide valve; this spring is so disposed as to press the plate against the back of the valve.

I have occasionally applied this valve to engines that required to have more steam thrown on to one side of the piston than on the other, and have thereby been able to do away with a considerable counterweight—for instance, in direct engines, where there is considerably more weight in the down than in the up stroke, I have found it very useful; and in another case, in which a cold water pump was attached to one end of the beam, and lifted water from a very deep well.

The motion of the valve being determined by an eccentric, is exactly the same as that of the piston determined by the crank, but with this condition, that the valve is at its greatest speed while the piston is at its lowest.

If the circle described by the crank pin is divided into equal parts round its circumference, the motion of the piston, commencing from the end of the cylinder, will increase as the versed sine of the arc described, until it reaches the middle of the cylinder, while that of the valve will be as the sine of the arc; and as the difference of the versed sines is constantly increasing, while the difference of the sines decreases, the result will be, that the motion of the plate I, on the back of the valve, must be less the longer the steam has to act upon the piston. The spindles of the tappets must therefore be worked by a motion of the same description as that of the eccentric, and this is obtained by means of the bell crank, A, B, the long arm A being worked by the governor, and made to describe an angle of 90°, the arm B, being horizontal when the governor balls are open, and vertical when they are closed; a graduated quadrant C, being fixed against the valve box, a hand fixed to the extremity of the arm B, of the lever A, B, will show during what portion of the stroke of the piston the steam is admitted into the cylinder.

The pin being pulled out from the lower joint of the lever E, the lever F, will be thrown up by the action of the plate I, against the tappets; the plate being no longer stopped by the tappets will be directed into the middle of the slide valve by the fixed bracket K, and the steam will be admitted to the piston until cut off in the usual manner by the slide valve.

When it is requisite to stop the engine, this pin must be withdrawn, because it is requisite that the plate I, should be always in the middle of the back of the slide valve to be ready for starting; the small quantity of steam that would otherwise be admitted would not suffice to start the engine.

This valve, which I have applied to a great many engines, and which has also been applied by others, answers perfectly well; it is, therefore, not merely a speculative idea that I am laying before your readers.

I applied one pair of them to a locomotive engine, but the result was not so favourable as I anticipated; not that this valve is not applicable to this kind of engine, but because I applied it in an improper manner, and without having beforehand taken into due consideration the several points in which the locomotive differs from other engines. I considerably increased the power of the engine, but did not save fuel, which is one of the principal objects I had in view. I made the cylinder too large; and did not sufficiently provide for the very great speed with which the piston of a locomotive travels, so that I produced in the slide valve the wire-drawing of the steam, which I avoided in the regulating valve; it must also be observed, that a sufficient blast must be determined in the funnel, to secure the generation of a sufficient quantity of steam; this was provided for, but in an improper manner, being only obtained by contracting the orifice of the blast, which would only enable me to obtain a proper effect under a given load and upon a constant gradient; and as on a railroad these two conditions are constantly varying, it is evident that the area of the orifice of the blast should vary also, not only when the steam is worked expansively, but on all occasions. I therefore took out a patent for an apparatus, by the use of which, the blast could be regulated with the greatest nicety, and obtained permission to make a series of experiments with the apparatus, on one of the most powerful locomotives, unfortunately not the one to which the expansion valve was applied, and the result was, what might have been anticipated; the variable blast did not require any assistance, and acted perfectly well in every respect; whereas the expansion valve, which requires absolutely the variable blast, did not produce its full effect without it.

From the very liberal conduct of the company, I am persuaded, that if I had remained longer in France, they would have authorized me to complete these experiments; but family affairs having called me back to England, they remain in an imperfect state, as far as regards locomotives. I, however, went far enough with the experiments to feel convinced, that by the application of the expansion valve in conjunction with the variable blast, a considerable improvement would be effected in the locomotive engine.

London, 19th October, 1842. H. H. Edwards.

Improvement in the Manufacture of Gas.—A workman employed at Esk Mill, Edinburgh, named J. Lothian, is said to have perfected a most important improvement, whereby a saving of one-half of metal, fuel, and fire, is effected by a new construction of the flues, and situating of the retort. His principle of building flues is also said to be well worthy the attention of those having small establishments, where gas is required. A few days since, he made, in $4\frac{1}{2}$ hours, by one small retort, 846 cubic feet of gas, the same being prepared from various substances.

THE YORKSHIRE ARCHITECTURAL SOCIETY.

Sir—However well-intentioned the regulation may be, that all who are admitted into this society "must be members of the Established High Anglo-Catholic Church," it appears to me to be one of a very questionable kind, whether as regards propriety or expediency. What is exactly meant by the Anglo-Catholic Church, I for one, know not, the term being to me altogether a novel one; but let it mean what it may, it seems that Anglo-Catholicism does not interfere with the "*peculiar sentiments*" of those who profess it! This, however, is touching upon different ground; what I have to object to, is the mixing up religion at all with secular matters, for the doing so is apt to lead to the former being made use of as a mere stalking-horse, and rendered subservient to worldly interests.

Had the restricting *sine qua non* been that all members must be thoroughly acquainted with *Ecclesiastical architecture*, that would have been a very intelligible and proper regulation, and would have answered every purpose, if it really is supposed that no one who is not likewise a member of the Anglo-Catholic Church, can have suitable feeling for, or do justice to that particular style of the art. Or if such be not the case, why should the society exclude architectural talent and ability merely because they may not happen to wear the badge of what it holds to be religious orthodoxy?

If such affected strictness be not *cant*, I know not what is. As far as religion is concerned, it would perhaps be more honest and more consistent on the part of the Protestant church, sternly to reject at once and altogether, whatever, in any degree, partakes of, or reminds us of Roman-Catholicism, its idolatrous worship, its vain and puerile superstitions. Instead of deploring the barbarous spoliations and ravages committed by iconoclasts and puritans, we ought to abstain from attempting in any degree to revive or encourage a taste for a style of architecture, to which we can never do complete justice, but at the very best must always remain immeasurably behind the original models, if merely because we neither have occasion for, nor can possibly admit into our churches, that amplitude of space, and that prodigal display of architecture and art, which, if it does not imperiously demand it, Romanism regards as manifestation of piety. For our churches, we require no long array of ailes and chapels; neither splendid sacristies, nor gorgeous altars: we have neither processions, nor saint-worship; in fact, do not even know anything of, or in any way recognise, many of the saints to whom our churches are nominally dedicated, or rather merely called after for form's sake, and in order to distinguish one building of the kind from another in ordinary discourse. What are St. Giles, St. Pancras, St. Olave, St. Chad, &c., to us Protestants, except so many names, which might as well be those of Egyptian kings?

Therefore, if such matters are of no moment—no scandal to our Protestantism, why should we now become all at once so excessively scrupulous in regard to what are equally matters of indifference? If it can be shown that it is indispensably necessary a man should belong to the Anglo-Catholic Church, in order to acquit himself worthily in building churches, let it be done.

Rickman, who understood Gothic architecture and our ecclesiastical buildings, as well or better than most in the profession—although Gwilt has not thought either him or his work worth any mention—was brought up in the tenets of quakerism, which, though it did not prevent his being employed professionally at some of the colleges at Cambridge, would now have excluded him from the Yorkshire Architectural Society.

It may be said that all this has scarcely anything in common with the objects of your *Journal*, and it certainly ought not; but if people will mix up religion and party spirit, such matters must unavoidably be agitated, and find their way into publications like your own. If qualification of any kind be required from those who seek to become members of the Yorkshire Architectural Society, it would surely be sufficient precaution against the admission of the unworthy, were it made a law that every one—at least every one actually belonging to the profession—should send in as a testimonial of his ability, some original study or design in ecclesiastical architecture; and if his taste should be found orthodox, he might be allowed to pass muster without inquiry as to the orthodoxy of his religious tenets.

I remain, &c.,

Q. E. D.

CANADIAN BOARD OF WORKS.

Sir—As you have uniformly taken high and strong ground when discussing the policy of constructing public works by Government, viewing the system as injurious to the community as it is degrading, and indeed, ruinous to the profession, the following remarks on some of the works now in progress or to be soon undertaken by the provincial government of Canada, may not be without interest to your readers. I believe this the more readily, as you some time since (Vol. III, p. 122 et seq.) copied an article from the American *Railroad Journal*, showing the, in every way, injudicious and demoralizing effects of the system here, which paper I should have had much pleasure in condensing for, and otherwise adopting to the English reader, had I supposed the communication useful to you otherwise than as a reference. What I now offer on the public works of Canada, will only too clearly show, that it is not easy to speak too strongly of the wretched system of carrying on these undertakings by agents of government, and with the public money, without any other responsibility than that to party.

My remarks will be confined almost exclusively to the "Improvement of the St. Lawrence," by canals round the rapids above Montreal. These canals are three in number.

1. The Lachine canal, round the Lachine rapids, connecting Montreal with Lake St. Louis, a distance of nine miles. This canal has been in operation nine or ten years, and the locks are 100 feet long in the chamber, 30 feet wide, and 5 feet deep.

2. The Beauharnois canal, on the other or south-east side of the St. Lawrence, connecting Lake St. Louis with Lake St. Francis, round the Cascades, Cedars, and Cotean rapids. This canal was commenced in July last, will be from 12 to 15 miles long, is to have locks 200 feet long in the chamber, 45 feet wide, and 9 feet deep on the sill—total lockage 82 feet, prism of canal 120 feet at water line, 80 feet at bottom, and 10 feet deep. Estimated cost £255,900 currency = £214,000 sterling.

3. The Cornwall canal connecting Lake St. Francis with the river above the Longue Soult rapids. This canal is nearly or quite finished, is 11½ miles long, with locks 200 feet long, 55 feet wide, and 9 feet water on the sill. Prism of canal 140 feet at water line, 100 feet wide at bottom, and 10 feet deep. Lockage about 48 feet, cost above £400,000 currency, without any protection to the inner slopes; a precaution found indispensable on the enlarged portions of the Erie canal, (which are only 70 feet at water line, 42 feet at bottom, and 7 feet deep. Locks 110 feet long, and 18 feet wide.) The excavation of the Cornwall canal was very heavy.

Besides these, there will be several short canals round some of the worst points in the river, which, for the next 35 miles, has a current of from three to eight miles per hour. The aggregate length will be about 40 miles, and the total lockage about 180 feet.

You will observe that the Beauharnois canal has been commenced on the *south* side of the St. Lawrence, in justification of which the chairman of the board of works wrote the letter, a copy of which, in a Montreal paper, I forward to you. The gentleman, in consequence of whose remonstrance this was written, engaged me to examine the question, and, finding no data, or indeed, any engineering information whatever in that paper, I was under the necessity of making such surveys as would enable me to give an opinion, which was to the following effect, that, the incidental works being trifling, and the lockage of course the same on both sides, the difference in cost, £105,000, must be sought for in the earth-work. But, the total cost of this on the north side, was, by my estimate, only £110,000, or, by the prices of the board of works, about £95,000, so that the difference of £100,000 became quite impracticable, as is indeed at once obvious to any eye at all accustomed to judge of ground. *After* my reports were laid before the select committee at Kingston, the board sent in their "estimates," unaccompanied by any report, in which they make out their case; by,

1. Comparing the *worst known* line on the north side; that is, the *last* line run by the board, and designated as No. 10 in the letter I send you, with the best line on the south side, thus making a difference of £40,000 against the north side.

2. By comparing a canal 15 miles long on the north side, reaching from still water to still water, with a canal 12 miles long on the south side, having its western terminus at the foot of a strong current, with extensive rocky shoals between the mouth of the canal and Lake St. Francis, difficulties, which I showed in my evidence, it would cost at least £40,000 to overcome.

My reports will be found in the evidence, a copy of which will be sent to you, and they will enable you at once to sift the facts from the vast quantity of irrelevant matter, with which the board have endeavoured to mystify the very simple points on which the investigation turns.

I will now request your attention to a dispatch of the Colonial Secretary to the Governor-General, dated 2nd of April, 1842, in which Lord Stanley writes: "It can hardly be doubted that works so extensive, and calculated to produce such important results, ought to be superintended by the best professional assistance which it is possible to obtain. Her Majesty's government entertain no doubt of the anxious desire of the Canadian Board of Works to discharge with fidelity the arduous duties which will devolve upon them; but I can as little doubt the anxiety which they must feel to have associated with them in such a trust, the best professional assistance which it is in the power of the mother country to furnish.

"It is therefore, my intention, in anticipation of the acquiescence, which I cannot for a moment doubt, of the colonial legislature, in the general arrangements suggested by Her Majesty's government, to send over an officer of engineers, whom, as Her Majesty's commissioner, I trust the legislature will have no difficulty in associating with the board of works, in the superintendence of the works to be undertaken; and whose experience may probably enable the undertakings to be conducted with the efficiency and economy which must be alike the interest of the colony and of this country."

Sir Charles Bagot replies, 28th of April, 1842: "Of course, as her Majesty's government provide the funds with which the public works are to be conducted, it is but reasonable that they should have a share in the management of it, if so desired."

His excellency then goes on to object strongly to a "military engineer," and suggests a "civil engineer," an expense it is well known the home government will not incur; in the mean time the work is commenced before even the centre line or the levels have been established.

Lord Stanley writes on the 2nd of July, 1842: "In your dispatch of the 28th April, you admit the necessity of appointing an engineer officer, as commissioner on the part of Her Majesty's government, to superintend the execution of the works which may be undertaken, and point out the reasons which induce you to prefer a civil to a military engineer.

"On this subject, I have only to observe, that if provision be made by the legislature for the payment of such an officer, (which, I agree with you, will be very desirable,) Her Majesty's government would have no preference for a military over a civil engineer, nor any wish on the subject, but to procure the services of the most competent person who could be engaged for this purpose."

Now, I have no hesitation in asserting, that, had this officer been sent out the canal could not possibly have been placed on the south side of the St. Lawrence. For, the examinations which he would have found it his duty to make, *before* giving his acquiescence, would have shown him that the south side had no advantages in an engineering point of view; and no English engineer, civil or military, could well tolerate the position of the Governor-General, that "ceteris paribus" he should "*probably*" (!) give the preference to the north side. The stern reply of Lord Stanley to this flippant remark, in which he expresses "his regret" at the "sacrifice of the military advantages" of the line on the north side of the St. Lawernce, cannot fail to strike you as proper and manly, as well as decidedly called for.

But the great object of the work is commercial; and, in this point of view, the examinations of the engineer of Her Majesty's government, would have shown him, that the line on the south-east or *lee* side of the St. Lawrence, must on that very account, and with any expenditure, be *somewhat* inferior to the line on the north-west side; in other words, that the "military advantages," so highly prized by Lord Stanley, were to be "sacrificed" not to aid, but rather to injure the commercial interests of the country. So general is the belief in the want of common honesty evinced in this transaction, that the large sum (£30,000 or £40,000) already expended on the south side, constitutes *now* the only argument in favour of continuing it on that side of the river. I am, however, of opinion, that this will avail little, if Lord Stanley send out an engineer—civil or military, I care not which—who, with even a little practice, is not deficient in self-respect and integrity. Such a man will soon discover, that a canal adapted to the trade of the country, will be worth more, both as regards facility of working, and—what is most important—low tolls; which latter must obviously be in proportion to the cost, than a canal of the present preposterously colossal dimensions. Hence, even £100,000 may be spent on the south side; and the commercial as well as national interests may be advanced by the construction of a canal on the north side, in such a manner and of such dimensions as prudence, experience, and common sense shall point out.

Lord Stanley will hardly brook being told, that, the canal having been commenced, it is useless to look back—that it is better now to submit to the imposition, infamous though it be, than sacrifice the work already done—that the honour of the government will be sufficiently appeased by dismissing the board of works with disgrace, and similar arguments of those whose only escape from a wretched bargain—if so mild a term may be applied—lies in the momentary and imaginary value which the construction of a "ship canal" to the "great lakes" along the Seigneury of Beauharnois may give to that property in the London market. But should Her Majesty's government sift this matter thoroughly, not only may the canal on the south side be stopped, but Sir Robert Peel—the unwavering friend of private enterprise, the grand secret of British supremacy—whose policy would never have originally given the imperial security for £1,500,000 sterling, "*cette pilule dorée*," as it was contemptuously termed by a leading French member of parliament—may feel himself called on to cancel the endorsement, when he discovers that the munificence of the home government serves only to the direct injury of the commercial interests of the colony; to the neglect of the military interests of the present state; of the agricultural interests of the colony; and, worst of all, to the demoralization of the colonial government and people. For, not only does the present course resemble that of the worst of the subsequently repudiating states, but there is superadded a degree of cool and mendacious effrontery almost incredible, on which, indeed, the main chance of success now rests. Thus, after reading Mr. Killaly's letter, you would be surprised to learn, that, the "French engineer" is *supposed* to have been a Canadian surveyor, his very name being even unknown. Survey No. 2, by Mr. Mills, led that gentleman to give the preference to the north side, (Nos. 4, 7, 8, 9, and 10, have obviously no bearing on the question.) No. 5 was by a country surveyor, and he merely points out some disadvantages in one route on the north side. No. 6, Mr. Baird never examined the north side; and, though in Kingston at the time, was not called in by the board; the superior "economy, and facility of navigation," consist in a violent current and lee shore; that a vessel which can navigate the canal, can neither get in nor out at the western terminus; that the three channels are pure fabrications, and that this is not the first extensive public work "undertaken through a district entirely settled and inhabited by Canadians of French origin." The Champlain and Lawrence railway runs through such a country, and was built almost exclusively by these Canadians; the Chambly canal also traverses such a country. On the latter work I served as assistant engineer in 1834; and the former was built under my directions, *by the day*, and opened in July, 1836. The evidence shows all this and much more; but I will proceed with some observations on the commercial prospects of the St. Lawrence canal.

The grand object of the undertaking is to attract to the St. Lawrence a large portion of the western trade, on the assumption, that the larger the canal, the lower the rates of freight; and, secondly, that the cost of transportation from the great lakes to Montreal, is the only drawback to an unlimited trade with the west—positions altogether untenable.

Barges now descend the St. Lawrence from Lake Ontario to Montreal, with from 100 to 150 tons freight, according to the depth of water in the "Cedar Rapids," where the barges frequently touch on the boulders, with which the rocky bed of the river is covered. There is only 4½ feet water here in the autumn, but, by clearing out the channel, it is believed that boats drawing 5 feet water may descend at all times. Such boats would carry 150 tons, or, if made of iron, 200 tons of freight, and with a proportionate reduction in the cost. A bill appropriating £10,000 currency to the improvement of the Cedar Rapids was introduced at the late short session, and the prerogative alone prevented its passing, as it met with universal favour. I send you a sketch of the contemplated plan, with a description in the *Montreal Gazette*, by Mr. Henry Roebuck, the projector of this, the first attempt to improve the downward navigation of the St. Lawrence. The average regular charge is 1*s*. 9*d*. currency per bbl. of flour from Kingston to Montreal, a distance of more than 200 miles by the river = ·195*d*. currency per bbl. per mile = 18*s*. 3½*d*. currency = 15*s*. 2*d*. sterling per ton of 2240 lb. (Flour was carried during the late summer for 1*s*. sterling per bbl.; and merchandize was carried up for 25*s*. currency = 20*s*. 8*d*. sterling per ton, by the Rideau canal, a distance of 240 miles, during a strong competition.) The *tolls* on the present Lachine canal are 2*d*. currency per bbl. of flour for 9 miles = ·222*d*. currency per bbl. per mile, or more than twice the total cost per mile through, ·105*d*. currency, as above.

The Erie canal of New York, with which these canals are to compete, has locks 90 feet long, 15 feet wide, and 3½ feet water, prism of canal, 24 feet at bottom, 40 feet at water line, and 3 to 4 feet deep. The tolls are 1*s*. 9*d*. currency per barrel of flower for 363 miles = ·0578*d*. currency per barrel per mile = about one fourth the tolls of the Lachine canal! thus showing an immense advantage in favour of the Erie canal—an advantage due to the cheapness of its construction; in other words, to its reasonable dimensions. How then is transportation to be lessened, by expending two or three times its original cost in enlarging the Lachine canal? The high tolls have driven the forwarders to try the Lachine Rapids, and during the past summer and autumn a vast number of boats have gone safely over. There is a great depth of water, but the channel is narrow and crooked. (The descent is about 30 feet in 1½ to 2 miles, which is passed in 4 or 5 minutes, the inclination of the surface of the water being such, that the force of gravity acts on the boat, thus producing a great velocity through the water in addition to that of the current. A heavily laden barge overtook a light steamer in the rapids, fortunately without injury to either—and the first season of this navigation has passed without accident.)

Now were individuals expending *their own* money on these canals, they would endeavour to ascertain whether the income—the true test of the accommodation to be offered to the trade—would justify the construction of canals of a size unknown, in Christendom at least, and would enter into the calculations and investigations necessary to show *how* this reduction of freight was to be effected, and *why* barges of 150 tons were so much less efficient than vessels of 800 to 1200 tons. But, in place of this, the public have heard nothing beyond such vague assertions as, that "the St. Lawrence is the natural outlet" for the "boundless trade" of the "far west;" if the Erie canal, with its pitiful craft of 50 tons burden—omitting all mention, or more probably ignorant of its small cost and low tolls—has yielded such large returns to the state of New York, what may not be expected from the "ship canals" of Canada, when "sea-going" vessels shall "float on Ontario and Erie," the Welland *schooner* canal connecting these lakes to the contrary notwithstanding—and innumerable other equally preposterous views and bombastic expressions, which are only too likely to prove as ruinous as they are ridiculous.

Yet this little Erie canal, which the State of New York has been endeavouring to enlarge to a size somewhat greater than that of the—according to Canadian ideas—little Lachine canal, and on which she has thrown away £3,000,000, is now admitted to be equal to any trade which can be expected, though there is no St. Lawrence to distance all competition for the down freight, no Rideau to compete with for the up freight, and although it enjoys a monopoly of *all* western freight, the people of New York not being permitted to use the railways along side of this canal on any terms—not even in winter—for the transportation of freight. These railways are owned by private companies, the government dreads their competition, and not without reason. For instance, flour is carried from Albany to Boston for 1*s* 6*d*. sterling per barrel, a distance of 200 miles by railway, through, or rather across, a mountainous country, or at the rate of ·09*d*. st. per barrel per mile, in small quantities (in full loads for 1*s*.); the rates from Buffalo to Albany, 363 miles, average 3*s*. 3*d*. st. per barrel of flour, or ·107*d*. st. per mile = 16 per cent. more than the highest charge on the Western Railway of Massachusetts. This latter is a private work, open throughout the year, and without any monopoly; the Erie canal is a State (government) work, closed between 4 and 5 months every year, and sustained by a monopoly unparalleled on either side of the Atlantic. The enlargement of this canal is postponed indefinitely, and a direct tax on every species of property in the State has been laid, to meet the interest of the money squandered on this and other legislative engineering follies, pointed out in Vol. III. (p. 122 *et seq.*)

Without stopping to inquire how soon this course will become necessary in Canada, I will ask, what intelligent Canadian or Englishman, who has visited New York and Canada, will for a moment tolerate the idea, that the trade of the latter country is likely to require, not equal, but ten times greater accommodation than that of New York? Should the trade of the St. Lawrence, twenty years hence, equal that of the Erie canal at this time, it will show an increase unequalled in the annals of this country. Look at the most, if not the only, successful work in Canada, the Champlain and St. Lawrence Railway, 15 miles long, and which cost not quite £40,000 sterling, on which 50 per cent. has been paid to the stockholders during the last six years, *because* the capital was small, and the outlay made with some reference to income. Had this been made with three or four tracks, on the scale of the Great Western Railway, it would have been as profitable to the stockholders as the St. Lawrence canals are likely to prove to the Province. One mile and a quarter of the Cornwall canal has cost as much as the 15 miles of railway, including cars, engines, buildings, wharms, and steam forage-boat of 300 tons, whilst the income bids fair to be inversely as the cost; a fair illustration of the mode of conducting public works by private companies, as compared with that generally pursued in New York and Canada, where the helm is only too often in the hands of political adventurers and desperate speculators, who, having every thing to gain by governmental extravagance, naturally employ kindred spirits to execute their designs, which are, usually, the expenditures of large sums in certain districts, without any regard to the wants or interests of the community.

The gross receipts on the Erie canal for 1840, were 1,597,334 dollars = £330,028 st., and the present year will yield about the same amount. Assuming the St. Lawrence canal to be about one-ninth the length of this canal, and supposing the same business, the receipts would be very nearly £50,000 cy., on an estimated expenditure of £1,043,074 cy. as per Mr. Killaly's memorandum of 12th Aug. 1840, in which occurs the only argument (!) vouchsafed to the community for the necessity of this additional accommodation to the trade at such enormous cost.[1]

On the Erie canal the up freight or merchandize yields only one-fourth of

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[1] The following choice *morceau*—the style of which is worthy of the reasoning—is all I have been able to discover.

"General Observations. The necessity of involving the province in the cost of forming a second water communication with tide-water, has been for a long time the subject of dispute and argument with many. Among the number of those who doubted the prudence of it, I was one until latterly; but the vastly increasing trade, *doubling almost annually*, and the conviction upon my mind, after mature consideration, that the lowering of freight consequent upon affording additional facilities, together with the productiveness of the western countries, which are only now coming into operation, will increase still further this trade *to an almost inconceivable extent*, have convinced me that a second and more facile outlet is called for. Besides the transport being confined to the Rideau, the navigation of which depends upon the stability of dams of great height, (in one case 60 feet,) should any injury arise to one of these dams, (as was apprehended last spring,) either through accident or malice, the effects of it would be ruinous to half the commercial interests of the country.

"I am decidedly of opinion, that the scale upon which the Cornwall canal was undertaken, was unsuited to the means of the province, and was not absolutely necessary for the greatest increase of trade, which the most sanguine may look forward to; and that a schooner navigation, combined with a system of tug-boats would have answered every commercial purpose; but now, from the large expenditure already incurred upon the central portion, *the little required to complete it*, and the comparatively small saving that might be effected upon *what remains to be done*, by adopting the schooner scale, I am led to conclude that the best and easiest course will be to open the St. Lawrence throughout from Montreal to Lake Ontario for steamboats and schooners—not upon the *full size* of the Cornwall canal, but on a scale sufficiently large to admit a powerful class of steamers or tug-boats to pass." (Memorandum, 12th Aug., 1840, p. 5.)

It is scarcely necessary to say, that the "doubling almost annually" is bombast to an almost inconceivable extent; that "the small saving" is no less than on 28 miles out of 40, and the diminution consists in reducing the canal from 140 to 120 feet in width, and the locks from 200 by 55 to 200 by 45—a distinction without a difference you will say.

the income; on the St. Lawrence, the ratio is much more unfavourable, probably not less than 8 or 10 to 1, as the Western States, which furnish the flour and pork for the Montreal market, receive their merchandize exclusively by way of New York and the Erie canal; hence the greater the exports or down freight *via* the St. Lawrence, the greater the imports or up freight *via* the Erie Canal. But the down freight for Montreal will, practically speaking, all go by the river; hence £8,000 to £10,000 gross income would be a high estimate for the up freight of the St. Lawrence, if charging the same tolls as on the Erie canal, or four times that income at the present rates of the Lachine canal. Some little income will also be derived from the occasional passage of the steam-tugs employed to tow barges between the different sections of the canal. It will be observed that this calculation supposes the trade equal to that of the Erie canal, and that the estimates are entitled to confidence. The difference in the former is such as to forbid comparison, and the mere dimensions of the Beauharnois canal, given in the beginning of this paper, will be quite sufficient to show the inaccuracy of the latter—to say nothing of the actual cost of the Cornwall canal, built principally under the superintendence of the able resident engineer of the Beauharnois canal.[2]

It is quite unnecessary to point out the improbability of vessels of 600 800, or 1000 tons or larger steamers competing with barges of 150 tons drawn by horses on the canals, and by steam or wind, as at present, on the river between these canals; but, when we find that the latter craft can descend the St. Lawrence (without paying tolls) with seven-eights of the freight, and that a suitable canal for the ascending trade would cost about one-fourth as much as the "ship canal," and be more efficient too, we are led to conclude that the whole affair would do no discredit to the "par excellence" land of jobs itself—the "sister island." The enlargement of the Lachine canal is about to be undertaken the coming winter, estimated cost £225,300 currency; and how this measure is to reduce the enormous tolls of that canal, which have already forced the trade to try the river, and successfully too, is a question not to be answered—in the affirmative, at least. The greatest possible reduction in freight I consider to be 6*d.* per barrel of flour, an amount quite insufficient to increase the demand in England, the very source of this trade, whilst freights from Montreal vary during the season not less than 2*s.* sterling per barrel, according to circumstances; a vastly more important consideration than any diminution which can be even anticipated between Montreal and Kingston. (The last Montreal quotations were 6*s.* sterling, from New York 1*s.* 6*d.* sterling, per barrel of flour.)

The Toronto paper, accompanying this, gives very fairly the general view taken by the entire agricultural and no small part of the commercial community; and, in confirmation, I will add, that by none did I hear the idea of using the canals for down freight ridiculed so much, as by French members of parliament, whose knowledge of the capacity of the river is nearly equal to that of the forwarders themselves.

A variety of other important facts might be adduced and different means taken; among the rest, the amount of business necessary to clear expenses and interest; and the amount of income which the present trade would yield; also the quantity of freight from western states seeking the New York market *via* the Erie, or Welland and Erie Canal.[3]

[2] The respectable British and American engineers who are, have been, or may be employed by the Board of Works, must not be confounded with the Board proper. They have merely to execute what their superiors, as politicians and intriguers, but their inferiors as men and engineers, are pleased to direct, and have nothing to do with the projecting of the works, as will be easily believed.

[3] Taking the interest and expenses at £60,000 currency, and the toll at 3*d.* currency per barrel of flour, it would require 4,800,000 barrels, about 7 times the present trade, to furnish the income, if even this comparatively moderate toll would induce boats to use the canals, and if the estimates of cost are correct. Besides the toll on the freight, the *boat* pays 1*l.* toll, and 12*s.* for towing through the nine miles of the Lachine canal, which for the 40 miles of canal would cost more than insurance and pilotage from Kingston to Montreal. The insurance is three-eighths of 1*d.* per pound; the pilotage about 2*l.* per 1000 barrels.

Allowing 30 minutes for passing one lock, and the entire present annual downward trade would pass through the Cornwall canal in 24 hours—the up trade before dinner, or at a point before breakfast. The river is equal to millions of tons per day, and the vast saving of time—already important between Lachine and Montreal—is an inseparable argument against the canals for the *down* trade—in other words, for *the* trade. The earlier and later navigation in spring and autumn is also important.

The Welland canal cost up to August, 1841, £491,777 currency, and requires, by estimate, £450,000 to complete it. (Memorandum, 12th August, 1841, p. 3.) The income for the last three years, has been about £25,000 currency, Mr. Killaly's "doubling almost annually an inconceivable extent" to the contrary, notwithstanding. The principal part of this is from down-freight, and a part also from American trade. With a navigation equal to that of the St. Lawrence, the income would be about £6000. Its principal hope of success rests on its becoming an American thoroughfare, which I think it eventually will be, for reasons given in my paper on "the spring trade" in the American *Railroad Journal* of April 15th, 1842.

Vessels drawing 12 to 14 feet water are brought with difficulty up to Montreal; and as for taking "ships" through 500 feet lockage up to Lake Erie, it will be at once obvious to the readers of the *Journal*, who have any acquaintance with inland navigation, that such views can be entertained only by those who are ignorant of the cost, weight and awkwardness of ships in canals. Should the trade become great, it is clear that the transhipment will take place at Quebec.

However new these statements of business may be to many of your readers—and obviously indispensable as they are to a correct understanding of the wants of the trade of the St. Lawrence—I believe they will be quite as new to the Canadian Board of Works, supposing that a Journal advocating such principles as this should accidentally meet their eye.

It was remarked, by the President of the Institution, (I think,) that many of the young engineers of England must necessarily look to the colonies for employment, hence the state and prospects of the profession in Canada cannot be received with indifference by British engineers in general; and it is on this account that I think the course of the Canadian government should not escape the scrutiny of the leading members of the Institution in London.

The honour and advancement of the colony and of the profession, as far as public works are concerned, must be considered as the same; and it is hard to say whether the Canadian Board of Works are doing more to injure the trade of the country, to degrade the engineer, or to effectually extinguish in Canada, that vital principle of British institutions—private enterprise.

I am, Sir,

Your obedient servant,

New York, 30*th Nov.*, 1842. W. R. Casey.

THE EDUCATION OF AN ENGINEER.

To which is added a few remarks bearing on the prospects of Engineering and its Disciples.

By H. F. Clifford.

Our estimate of the value of any scientific pursuit, consists chiefly in the degree of importance we assign to the amount and nature of the several qualifications due to its proper attainment. When we reflect upon the characteristics of engineering, we are not long in discovering it to be a science requiring much deep and intellectual study, assisted by steady perseverance, long and unceasing application to arrive at a just appreciation of all those practical data which experience can alone furnish, and impress vividly on the mind; one in which the laborious duties of the artisan must be blended with the sound theories of the refined mathematician, one, in fact, embodying the perfect union of theory with practice; but to define engineering in the full sense of the word, would be an endless task, for in that single word is comprehended a general knowledge of all the artifices that human ingenuity can devise to supply the conveniences of the present advanced and rapidly progressing state of civilization. This definition may, indeed, appear vague to some; but when we are informed of the vast grasp it takes of all those sciences which require no ordinary mind to cultivate and condense for the purpose of obtaining a thorough comprehension of the numerous ramifications of so noble and deeply interesting a study, we cannot be called presumptuous in placing it second to few, if any of our standard professions. Since, however, engineering as a comprehensive and distinct science has become fully recognised, and taken up its full position high in the rank of secular callings, there must have been long felt a growing deficiency of some fixed laws or definite principles to guide such individuals as were desirous of attaching themselves to the profession as a means of support, in obtaining a thoroughly useful knowledge of the subject. It is not our intention to throw any unreasonable objections in the path of the young aspirant to engineering fame, but we would seriously urge on his attention the necessity of engendering at the onset a firm and unchangeable resolution to encounter numerous and severe difficulties; but to be forewarned is to be pre-armed, and in the following remarks, which are the substance of a few years' careful observation, we have endeavoured to point out the general features of such a course of probationary study as from experience we have great confidence in recommending for adoption; being fully persuaded, moreover, that the only way to render engineering ultimately serviceable, at least in a pecuniary point of view, is to effect the happy combination of the practical with the civil department. For it is almost chimerical, now-a-days, for any person to imagine he will ever succeed solely in the capacity of a "Civil Engineer," inasmuch as civil engineering is a profession commanding but a very limited practice, and that what practice there is must inevitably fall to the lot of men whose public works have already earned for them an undying name, and with whose lives it will perish as a distinct avocation. Neither, on the other hand, can we recommend any one to pursue practical engineering alone, that is the business of an engine builder, for it is one requiring large capital to erect workshops and supply them with the necessary machinery; and moreover, there is not nor will there ever be now, a sufficient demand to employ all those first-rate works that have been established for many years, and whose name is a perfect guarantee for a good article. Again, owing to the slow but gradual development of the system of constructing manufactories on the continent, conducted by skilful Englishmen, there is every reason to believe that when the system arrives at a state of maturity, the foreign consumption of English machinery, especially locomotives, will be almost entirely annihilated. It is true, however, that there is a body of men, managers of large works, receiving no despicable salaries, and to a casual observer their occupation presents fair means of remuneration; but then what man is there accustomed to the usual comforts of life who would sink the better part of his early life in a workshop, as would be necessary to fulfil creditably such a situation? No. Such offices are chiefly held by men who, originally of the better class of mechanics, have gradually raised themselves above the level of their brethren by the exhibition of no ordinary talents, and have thus become entitled to the appointments as being the fittest parties from the nature of their previous education and intercourse with men whose habits and discipline they are best able to appreciate and to govern. With these few useful premises we now proceed to show the requisite functions to qualify a man to act successfully as an engineer. Let it be ascertained, as early as possible, that the person in question intends becoming an engineer, for having determined this important point, no time will be lost in acquiring any information foreign to the purpose. Latin and Greek must be entirely eschewed, and in the earlier portion of the student's career, let him obtain a tolerably clear knowledge of geography, history, arithmetic, English, French and German, the rudiments of ornamental drawing, sketching, the first three books of Euclid and Algebra. The consideration of the above will possibly occupy the student's attention up to the age of fourteen. From fourteen to sixteen finish Euclid; take up practical geometry and the higher parts of algebra—read plane trigonometry, conic sections, mechanics, hydrostatics, and hydrodynamics, the differential and integral calculus, and in order to connect more firmly together the links of this mathematical chain, work numerous problems involving each and all of the several branches. The elements of geology and chemistry, and such other parts in detail as bear more immediately upon civil engineering have great claims on the pupil, whilst a strict attention should be given to mechanical drawing, sketching, linear, and isometrical perspective, with the theory of shadows. During this period, likewise, the student should make a practical investigation of surveying, and learn to use, with ease aad accuracy, the level and theodolite, to make himself acquainted with the general principles of architecture; and, in order to prepare his mind more fully for the reception of its future tenant, peruse some standard elementary work on engineering.

Having completed his sixteenth year, and assidiously devoted all his energy to the investigation of the foregoing subjects, let the embryo engineer be now placed in some first-rate manufactory, where there is a great variety of work executed, for a space of not less than three years. We repeat, *first-rate* manufactory, for as his standard of judgment of mechanical productions will be formed in a great measure by the quality of work passing under his notice during this time, it is proper he should connect himself with one of the highest repute. Here he will lay up an ample store of solid information regarding land, marine, snd locomotive engines, mill-wright work, and, in fact, machinery in general. But this information, we can assure him, is not to be purchased in the character of an on-looker. He must keep the same hours as his fellow workmen *(pro tempore stante)*; he must exchange his ordinary attire for the fustian suit, the drawing room and easy chair for the workshop and the vice, and go through the various gradations of the service till he is found competent to undertake some responsible situation over the workmen. And it is a well known fact, that it is impossible for a man to pass a correct and conscientious opinion with regard to the execution of any mechanical work, unless the individual in question has himself gone through a regular system of practical application. It is true the beginner, unused to the rough habits of a workshop, and unaccustomed to associate with such characters of men as he finds there, will have to contend with many inconveniences and annoyances, but then he must make up his mind to wield the hammer, chisel, and file, with a firm determination to overcome all difficulties. We admit it requires a strong and persevering resolution, and many are they, beginning with a good heart but meeting with impediments at the commencement, have shrunk from the prosecution of a course of training, which, pursued to completion, would have amply repaid them the extra exertion due to its attainment. Locomotive building claims especial care for its subsequent utility, and let it be a leading principle throughout the entire course, to ascertain correctly and set a due value upon the proportionate strength[1] and properties of materials in general, that the engineer may be able to adapt with confidence such invaluable knowledge when he may hereafter find it available. For the *requisite* strength is alike conducive to symmetry of figure and economy of material—an intimate acquaintance with the relative functions of the various descriptions of water wheels[2] is indispensable to the engineer, on account of the great utility and *economy* of such power in countries and districts where water abounds, and where it would be both inconvenient and expensive to erect steam engines and their concomitant paraphernalia. The foundry must likewise have its due share of importance, and the student should contrive to obtain an introduction to some large iron works. Here he could devote a short period to analyzing the processes of smelting, puddling, casting and forging, and thus render himself capable of passing a good judgment on the quality of malleable and cast iron, when coming under his notice for engineering purposes on future occasions. Although mining engineering is reckoned a distinct branch, and requires long experience underground as a viewer to sustain any responsible situation, still a short time passed in investigating colliery work in some well regulated coal pit, would make the pupil acquainted with much valuable information concerning pumping engines, and the general routine of the mechanical department, as would be of material service to him. During his residence at the manufactory, practice in drawing should be kept up by periodical visits to the drawing office, and he should endeavour, on all occasions, to procure for himself copies or tracings of any useful piece of mechanism, and thus, by carrying the principle out in time, amass a series of practical illustrations of invaluable use in after life. Lastly, in order to render the former part of his education ultimately serviceable, the pupil should, during the evenings after work hours, peruse attentively such works as treat more immediately on subjects forming the constituent elements of his profession, and for the purpose of blending amusement with instruction, we could suggest reading at his more leisure hours, and thus keep pace with the constant improvements, the best periodicals that treat practically and theoretically of civil and mechanical engineering. Having completed the first grand epoch in the probationary regime, the pupil may easily refresh himself with the pleasing intelligence, that the remainder of his duties are comparatively easy to the ordeal he has already passed through. The next step is to place himself under the direction of an eminent civil engineer, who has railways and other works connected with this department of engineering under his superintendence in course of construction. In this new state of things, the pupil should strive hard to obtain some inferior, but by all means *active and responsible*, station, for there never is that care and attention bestowed on any object that is simply dependent on *our own* caprice. The pupil should, therefore, consider it a matter of paramount importance to endeavour sedulously to create a high confidence in his own and his superior's mind, that may lead, as soon as possible, to his entrustment with some minor office, the creditable discharge of which depends entirely on his own exertions. For confidence, let it be understood, is the capability of expressing a decided and correct opinion with regard to any question that may arise, and which can only be given in cases where a thorough comprehension by *experience* of the details of the point at issue is positively entertained. With civil engineering commences a new era, Railway making, with its surveying, levelling, cutting and embanking, bridge building, drainage and other works, will serve to keep the mind continually employed, in order to become well versed in all its minutiæ, The building of harbours, docks and light houses, the formation of canals, will severally claim a proportionate degree of careful consideration. Common road-making, warming and ventilating, general principles of carpentry and masonry, with a train of minor but no less useful qualifications, will in due order require each its own peculiar study: lastly a real concise method of making estimates and getting up specifications for contract works, will be found of great utility; the former can only be obtained by ascertaining on all occasions the prices of every description of materials for engineering purposes in the different localities, the latter by continual reference to specifications of works already executed. Here, then, is a broad field open to the successful practice of acquired knowledge, whilst design and construction present favourable opportunities for the display of any talents or ingenuity the young engineer may be fortunate enough to possess. To acquire a sound knowledge of the strength and properties of wood, stone, and iron, should be considered a matter of the utmost importance, and a few months could be profitably passed in an architect's office of good repute. We have mentioned the preceding qualifications *en masse*, but they should be carefully and discriminately adjusted to the age, ability, and progress of the student. Let the different subjects be presented to his notice in their most elementary shapes at the onset, that the rudiments of one and all may be indelibly fixed on the mind; for then the intellectual faculties having mastered the approaches, will grasp with a firmer hold upon maturer development the more complicated facts. And it should not be lost sight of, that the amount of information acquired, depends almost entirely upon the youth's own assiduity, as he will not find persons continually at his elbow, as in the schoolroom, either urging him on or threatening him with punishment for neglect of duty. He must see

[1] By proportionate strength we mean the relative strength the severa parts of any piece of mechanism should bear to one another.—Tredgold, Barlow, &c.

[2] Smeaton's experiments.

clearly it is to his *own interest* to make the best possible use of his time. It is not within the limits of an article for a Journal, to enter more fully into detail, but we have endeavoured in as brief a manner as consistent with the nature and magnitude of the subject, to draw the outline of a plan of education, that from *actual* trial, we can seriously recommend for adoption. We would fain conclude here, but cannot resist making a few passing remarks on the several schools for engineers that have lately sprung into existence. However radically good the principles and intentions of any establishment may be, professing to teach a young man engineering, however well such principles may be carried out and matured by able and efficient masters, they will fall immeasurably short of their purpose, when compared with the preceding course. For it is not within the limits of a school-room education, to convey that inestimable practical knowledge, which can only be acquired by constant every day association with bodies of men, whose daily bread is earned with the sweat of their brow, and who can readily and satisfactorily explain any questions or doubts that may arise connected with their individual trades. The latter course may, indeed, materially assist the embryo engineer in the earlier part of his career; but having arrived at a suitable age, the workshop, and then the open field, from the staking out of the railway to the laying of the permanent rails, will be found far more congenial to the spirit and practice of engineering. In conclusion, it is our decided opinion, that an individual educated according to our method, and possessing, in a fair degree, all the advantages arising from it, will be fully competent, at the expiration of his articles, to undertake some responsible and remunerating situation; and it is not too much to anticipate, that if he be an industrious and persevering character, he will materially benefit any works with which he may become connected; and with good natural talents, assisted by standard ability, he may possibly shine forth a bright star in the wide sphere of a distinguished profession; and should he not be fortunate enough to rival the memories of Brindley, Smeaton, Telford, Watt, Stephenson or Brunel, he may perhaps leave behind him lasting monuments of his skill, that would do credit to his more illustrious and deservedly renowed predecessors.

Now for a few words bearing on the prospects of engineering, and its disciples. When we review the statistics of railways, and reflect upon the enormous quantity of money (£70,000,000) expended by private individuals on such speculations, within the limited period of railway existence—when we consider the little return such parties have had for their invested capital up to the present time, the heavy loans several companies have still to pay off, notwithstanding the fallacious exhibition of prosperity, in the declaration of a moderate dividend to the shareholders—when, moreover, we consider the ruinous state of trade, the prevalence of distress, the sluggish circulation of specie this last two or three years, caused by the diffidence of large money holders to let it change hands—and when, lastly, we contrast the superabundant supply of engineering skill compared with the demand, we cannot feel surprised taking full cognizance of the above, and many other contingent circumstances, at finding engineering in the unpromising condition it has presented of late. It is now generally admitted, that profuse expenditure has been the prevailing feature of railways hitherto constructed; and it should be the aim of future companies to complete their engagements with as much economy as is consistent with the durability and magnitude of the undertaking. We do not object, let it be understood, to additional expense being bestowed on the great arteries diverging from the metropolis, for such may be looked upon as public works, and have a reputation to hold up; but he smaller veins branching from the main trunks, should be made at as little cost as possible. Once let a right spirit of economy be established between the directors of railways and their engineer, and we shall soon have public confidence restored, and a new impulse given to the profession. There are many lines that must be laid out and finished, to render the ramifications of the system complete in England. The grand link connecting Scotland—will there not be two?—is yet wanting in the chain. Ireland is as yet untouched—would not a good system of internal locomotive communication go a long way to improve the civilization and better the condition of that unhappy and distressed country? This would be, indeed, desirable, if only for its moral and social effect. And is not her soil as capable of sustaining rails, and yielding profit too, as any other land? And we do think that, could the government overcome its present difficulties, and improve the revenue, it would do well to assist a spirited public in their meritorious desire to form a thorough railway connection throughout the entire kingdom, at least in such cases as presented ostensible means of remuneration for invested capital. It is true the public were too prone to believe, at the commencement of the railway mania, that in committing their money to the coffers of the company, it was to be multiplied to the unwarrantable height of their expectation; but their too sanguine anticipations were disappointed, and sad experience begat caution—we hope not discouragment; for it was not likely, upon contemplation, that an impetuous torrent, the characteristic of early railway speculation, bursting from its source, could dash on in its headlong course without meeting, at no very remote period, with some counteracting agency—some impediment to its success.

Now, when we meditate on the crowded state of the avenues to all descriptions of avocations for the last few years, we cannot feel astonished that, upon the introduction of a comparatively new profession, as engineering, public attention should be diverted into a fresh channel, and seize with avidity upon one holding out such promising advantages. At this period, too, there were comparatively very few men who had been really trained to the profession; numbers, however, upon ascertaining the necessary qualifications, went vigorously to work—but then time was an essential requisite to collect *materiel;* and in the interim a body of men, termed surveyors, possessing a tolerably good knowledge of their business, with a smattering of a few properties bearing some analogy to this branch of engineering, availed themselves of the opportunity, managed to get employed (for want of better substitutes) in some inferior capacity at first, until gradually acquainting themselves with a few of the details, arrogated to themselves the term of "Civil Engineers;" and before the genuine pupil had matured his education, these men had obtained, and do now hold, several of the best situations in the service. This incident will doubtless explain why there have been, and are, so many intelligent articled pupils out of employment; and it is a known fact that many have left the profession, their patience quite exhausted. Again, did the younger scion of a respectable family, in the innocence of boyish delight, sketch *anything* resembling a steam-engine, the anxious parent felt persuaded "the boy was a genius," and only required to be educated as an engineer to develop extraordinary talent. A great number of these geniuses, however, soon finding that engineering to be properly understood was no easy matter, floundered on for awhile, and at length gave it up as a hopeless business. Nevertheless there were many, having endured much tribulation, passed the rubicon, and thus swelled the numerical strength of the profession. It would appear, therefore, from the preceding analysis, that whilst the demand was falling off, the supply of *bona fide* engineers and self-entitled adventurers were increasing in a formidable ratio. The present aspect is, consequently, gloomy enough; but there is this satisfaction, if it be any, that, being at the bottom of the wheel, the next change will, in all likelihood, brighten the prospect. Upon reviewing the system of railway policy abroad, we cannot but advise the matured pupil to strive hard for employment at home before seeking it elsewhere; for Englishmen are not treated on the continent with that good feeling and generous acknowledgment of their worthiness to which they are justly entitled. There is likewise much jealousy existing amongst the French, and it almost invariably happens that such English engineers as have been led by promising hopes to enter into engagements have, upon a short trial of their continental neighbours, found their position so unpleasant as to cause resignation of office, if possible, and in default of that, to put up with much unmerited insolence, or have been unceremoniously discharged at the immediate expiration of the articles of agreement, but not before their wily superiors (in office, not abilities) have taken good care to reap a rich harvest of experimental knowledge from the solid acquirements of their *employés*. Many there are too, wearied with long inactivity, and despairing of obtaining situations in their own country have turned their attention to colonial prospects. But here, we fear, they will fall far short of their expectations; for the present condition of our colonies is not of that settled or flourishing nature as to favour the designs of the accomplished engineer. The fact is, a country must be in a tolerably advanced state of civilization—must possess extended commerce, internal trade—must have substantial resources of ITS OWN, and contain a strong body of capitalists devoted to the execution of public work, before it can be pronounced in a fit state to admit of engineering operations with any hope of success.

It is true a few *surveyors* may meet with encouragement in the more recent settlements of New Zealand and thereabouts, to head the exploring staffs in plotting out the ground for future emigrants, and there is no doubt of the existence of certain districts in America (especially the more southern parts) where the mechanical department might be carried on to a very profitable extent. But then what man is there, without some very definite plans for, and sure prospect of speedy success, a voluntary exile from father-land, and the comforts of home, with all its cherished attractions, could embark his living in such truly *outlandish* speculations. What are we to do then, is the general and anxious inquiry. Wait patiently, till the tide of fortune takes a more favourable turn, which we hope is not far distant. There is much left to be done in old England; and could the country once again recover from the depressed state, under which withering influence it has so long laboured, there is no doubt that engineering, like all other avocations, will quickly resume its former activity, and then every properly constituted member of the profession will meet with his due share of employment.

AN ARTESIAN WELL IN THE SEA.—An attempt is now being made at Brighton, to obtain water from beneath the chalk under the sea. The operations for this purpose are being carried on at the head of the chain pier, and it is confidently expected that the strata of chalk at this spot does not exceed 70 feet in thickness, through which, on arriving at the green sand, a constant unfailing supply of pure water is anticipated.

ROYAL ACADEMY.

Professor Cockerell's Lectures on Architecture.

(From the Athenæum.)

The Professor began by quoting the regulation of the Royal Academy as to the Lectures on Architecture—"That the Professor shall read annually six public lrctures, calculated to form the taste of the students, to instruct them in the laws and principles of composition, to point out to them the beauties and faults of celebrated productions, to fit them for an unprejudiced study of books on the art, and for a critical examination of structures." It is understood that these lectures were to be given by a Professor in the full practice of his profession, according to the dictum of Vitruvius, "that it is the union of the practice with the theory, that makes the sound architect"; and although he felt that it was precisely this circumstance that gave all the value in the eyes of the students to these lectures, yet it was obvious that in the midst of the distractions and bustle of professional practice, the Professor laboured under great disadvantages. It was much to be desired that the means at the disposal of the Royal Academy could enable it to extend these lectures according to the model of the French Academy, which, on architecture alone, had established five classes, each having a separate professor,—namely, 1, Theory; 2, History; 3, Mathematics; 4, Stereotomy and Construction (in which important class two *Repetiteurs* were appointed); 5, Perspective. Such liberal instruction secured the honour of the profession, and protected the public against empirical practice; and gave the French architects, in particular, that advantage in foreign countries, which the unassisted genius, perseverance, and enterprise of our own countrymen found it difficult to contend with. Aware of this mortifying inferiority in our public education, the students would exert themselves so much the more in their private studies to supply the deficiency, and would learn from this well digested system the course they should pursue. This Academy had, indeed, been founded by an illustrious prince (George III), and great were the obligations of the arts and the public to his memory; but the means by which it existed were of its own creation, and those means were barely sufficient to fulfil its engagement, to support gratuitously the only school of art which this country possessed.

It is an axiom with the civilized nations of the Continent, that the fine arts are eminently calculated to increase human happiness and exalt human character, and greatly contribute to the reputation as well as the real interest of a country, especially of a manufacturing country.

But the austere government of England makes the fine arts no part of its glory, its policy, or of its expense. And were it not for the sympathy and patronage of the public, even this limited institution could not exist; nor would the country escape the reproach of the Celestials of "outer barbarism." The fine arts have, indeed, the countenance of the supreme head, and of "the powers that be"—the Ministers of the day, who cannot, as gentlemen, renounce the attribute of taste; but they have uniformly shown by their public conduct, that they do not consider its support amongst the people a political duty.

It is now more than a hundred years that Thomson, the best informed upon the arts of all our poets, indignantly remonstrated on our national inferiority and neglect of this branch of intellectual culture, and complained with grief, in his Ode to Liberty—

> "That finer arts (save what the Muse has sung,
> In daring flight above all modern wing,)
> Neglected droop their head."

Foreigners have attributed this disregard of the rulers of an ingenious and a great people to various causes—to physical insensibility, to the sordid nature of our commercial habits, or the adverse propensity of the Protestant religion—to which objections the history of the ancient dynasties of this country (never inferior in the fine arts), the abundant enthusiasm of individual artists of our own times, and the public sympathy, are direct contradictions. Finally, they have fixed the reproach on the government, by pointing at the Schools of Design established by parliament; for they say, truly, that so soon as the inferiority of our design in manufactures drove us from the foreign markets, we took the alarm, and immediately formed schools of design, *à l'instar* of those on the continent; not from a generous love of art, but, confessedly, from the well-grounded fear of loss in trade. The members of this Academy hailed the measure with joy, as the harbinger of a better sense of what is due to our intellectual position in Europe, and they have willingly given their gratuitous attention to its conduct. But the instruction of youth must be accompanied with the higher prospect of employment and honour in national works; and we are happy in the reflection that the decoration of the parliamentary palace at Westminster, and the interest taken by an illustrious personage in that great object, hold out to us the hopes of equality at least in these noble studies with the improving countries of the continent, and the opening of a new career for genius and industry.

But an erroneous and mischievous scepticism as to the utility of Academies of fine art altogether, has long been fashionable, which has not, however, been applied to others, for no one has ever yet despaired because a Newton or a Locke are not annually produced from Cambridge and Oxford; but of these it has been plausibly said, that no Michael Angelos, Raphaels, or Palladios have been produced by them since their foundation in the 17th century; it is forgotten, however, that the patronage and immense employment which elicited the talents of those masters, have also been wanting; and that without the field for their development, and all the expensive machinery by which they can be brought to bear, Academies can do little more than preserve and transmit the rudiments of art.

Fleets and armies are necessary for war, and without these the greatest captain of his day might have been nothing more than an eminent professor at Sandhurst.

Academies were established as depositories of learning and practice in the fine arts, and the means of their preservation and transmission through the vicissitudes of the times. The enlightened and commercial Colbert had seen how in Greece and ancient Rome, and in modern Rome, under his own countryman, the Constable Bourbon, a public calamity might disperse and ruin them for half a century, without some fixed and corporate body and abode. He never dreamt that, in the absence of the fostering patronage and employment of government, the Academy could do more than fulfil these negative objects. The Royal Academy had done much more than this—it had sustained the credit of the country in fine art, and had reared talents which were now part and parcel of English history. Through good and evil report it had nourished the flame; and it was consolatory to find that they had transmitted it to better times, through long and adverse circumstances; for now they had the happiness to see two Professors in the Universities of London, the British Institute of Architects, large public patronage in Art-Unions, &c., and a growing interest in the Universities of Oxford and Cambridge towards fine art generally.

But Architecture, as a science dignified by an intimate connexion with the exact sciences, and by her acquaintance with those eternal laws of mathematics and of physics which are obeyed throughout the universe, was, in this Academy, regarded only as a fine art, and these lectures were designed to illustrate Architecture in that capacity alone. Dealing with the phenomena of beauty and ideality in the form and aspect of her contrivances, she becomes an essential member of the fine arts, the more essential since her conclusions are more undefined and remote than any other branches of the fine arts, save Poetry and Music, with whom her nearer relationship than with painting and sculpture, is sustained by many. But in all that respects the beauty of forms and their combinations, she must never forget her obligations to her sisters painting and sculpture, by whose aid alone she becomes the *ars regina*, and keeps in view her prototype, Nature, ever equally solicitous of beauty and of use. And the moment she declines their counsels, her proportions become anomalous, and she descends to the mere building art.

In Egypt, where painting and sculpture were in comparatively small esteem, and again in the middle ages, proportions were wholly capricious, and subject to no order or regularity; nor have any been ever attributed to them even by the greatest admirers of Egyptian or Gothic architecture. On the contrary, the Greeks, aided by the union of the three arts, soon established that analogy with the organized productions of nature, which fixed the proportions of architecture in so determinate a form as not to be safely departed from, and which, whether in the days of Phidias, or Raphael and Michael Angelo, or any other renowned period of art, has been approved and adopted as just and incontrovertible.

The fulfilment of the duty of the Professor under a limited number of lectures, had been a subject of some anxiety and difficulty. The history of the art was the only safe foundation of the study, and had, therefore, formed his first course. "Architecture," says Sir C. Wren, "is founded on the experience of all ages, promoted by the vast treasures of all the great monarchs, and the skill of the greatest artists and geometricians, every one emulating each other. And experiments in this kind being greatly expenceful and errors incorrigible, is the reason that architecture is now rather the study o antiquity than fancy." With respect to the duration and progress of this art, it might be said that a hundred years were but as a day; being made for ages, it could not, therefore, be subjected to the vicissitudes of fashion; and the slowness of its progress and invention ought to inspire us with respect for antiquity and the authority of example, and to repress that presumption which too often assumes to dispense with them.

In fact, at every epoch in which the art had raised itself to its highest conceptions, we find not only artists but theoricians, archæologists, and historians, occupied in describing its progress and inventions, illustrating its monuments, and seeking out its antiquities. There are many histories of architecture more or less complete; Canina's work promises to supply the history of ancient architecture which Winkelmann had left very insufficient. D'Agincourt's "Histoire de l'Art par ses Monumens" was an admirable work; it treated of the art from its decline to its revival and restoration. Durand's "Parallel des Edifices anciens et modernes," on the same scale, is highly illustrative of the history of architecture.

The second course (that of last year) had treated chiefly the literature of the art; following out the Academic instruction quoted above, namely, "to fit the students for an unprejudiced study of books in the art." It had been well said by a learned prelate, "that we do not live in an ignorant age, but certainly not in a learned one;" and it was painful to see those authors who had been canonized by ages, either attacked and discredited, as Vitruvius, or held to be antiquated and obsolete, as the old Italian and French authors, and above all, the admirable Alberti, the Bacon of the art, and others of the greatest interest. The obvious consequence was, that new lights, fashionable conceits, and heretical opinions, were conducting us into the large ocean of error. As well might the lawyer or the divine dispense with books as the architects. In the very dawn of literature the architect was required to be learned. In the Memorabilia of Xenophon, Socrates inquires, "But what employment do you intend to excel in, O Euthedemus, that you collect so many books? is it architecture? for this art, too, you will find no little knowledge necessary."

A familiar example of the great utility of these researches had been given in the quotation from Philibert de l'Orme (lib. ii. c. xi.), of the specification for concrete, written in the latter part of the sixteenth century, and corresponding precisely with the recent so-called discovery of this method of securing foundations. During the last century our architects had discontinued the ancient practice, having adopted the most fallacious fashion of wood-sleepers, to the ruin of many fine buildings. It was, then, the ignorance of this invaluable and most instructive and amusing author, Philibert de l'Orme, which had led to so fatal an error.

With reference to Vitruvius, the commentators, in forty-one editions, since his discovery in 1416, were shown to have made but slow progress, and to have done the author but little justice; and ever since the uncandid Schneider had published his edition in 1807, ten important discoveries, illustrating the correctness of his theories, had been made by modern travellers and architects.

In the present course the Professor purposed the consideration of the more difficult, but no less important, injunction of the Academic regulation, "that these lectures should be calculated to form the taste of the students, to instruct them in the laws and principles of composition, and fit them for a critical examination of structures."

Those laws and principles which are technical, were often treated, and were more obvious; but those which constituted architecture a fine art, were more subtle, but not less vital, to those who aspired to the higher attainments of the art, namely, the sublime and beautiful. Such inquiries had employed the most learned and ingenious minds in all ages; and although theories are proverbially dangerous things, and must be treated with great caution, yet, recommended as they are by the authority of great names, they ought to be known and discussed; effects attributable to right reason and right feeling are essentially subjects of discussion, and the old proverb should be reversed, and "De gustibus disputandum est" should apply to all those preferences which depend on reason, and not on sexual or fanciful arbitrament; and though the inquiries into the æsthetical of art, which have occupied the last century particularly, fall short of the results we should desire and expect, and that after all genius alone can rightly solve these questions, which elude common sense, yet we may cultivate and improve our critical powers, learn to think more accurately, and correct that colloquial laxity of speech which refers all impressions to some cant phrase of undefined signification, as *fine* and *beautiful, tasteless*, &c.

Such investigations afford the only means by which the principles of this or any other art can be ascertained, and the artist can be enabled to determine whether the beauty he creates is temporary or permanent, whether adapted to the accidental prejudices of his age or to the uniform constitution of the human mind; and whatever the science of criticism can afford for the improvement or correction of taste must altogether depend upon the previous knowledge of the nature and laws of this faculty.

In the following lectures the Professor proposes to review the examples cited in his former courses with reference to these important principles.

Lecture II.

The Professor said, that the developement of the human faculties was exhibited in the history of Architecture under its most favourable aspect. The art might be termed the epitome of of civilization, the first fruits of social order aud combination, of every discovery in science, and of every conception of beauty. Political history was of comparatively inferior interest, and betrayed, for the most part the depravity of our species. The natural labours of man, those of agriculture, or commerce, their unvarying succession, brief endurance, and disappointment, leave melancholy convictions; but in the occupation of architecture, man finds the employment of those higher aspirations and idealities for which he feels himself born, as well as of his physical energies. Here he perceives that he has a soul; all his loftier conceptions—order, calculation, beauty, and immortality—are opened to his contemplation, and he seems to feel the power of extending his works and his memory beyond the bounds of nature and of time.

The exhibition of these innate and physical capacities seems to be his natural desire; and the progress of his operations coincides with his intellectual growth. In his boyhood he contends with the forces of nature; he moulds the vast rocks, and rears on end the monolithic obelisk; or, accumulating the masses with laborious endurance in the pyramid, he emulates the works of Nature herself; and exulting in the force of order and combination, and his acquired skill, he exclaims, with the Babylonians, "Go to, let us build a city and a tower, whose top may reach unto the heavens, and let us make us a name." Add, although in our advanced civilization, we may smile at the superfluity of such labours, we must not forget that by them man first vindicated his capacities, and that metallurgy, mechanics, and all the manual exercise and discipline which fulfilled his apprenticeship to civilization, were brought into practice, which soon employed itself in more intrinsic benefits.

The age of Alexander and the Romans abundantly illustrated this truth Man now contends with the elements. The ocean is curbed by his ports, and quays, and Pharos; he sails across its bosom; marshes are drained; sewers, canals, aqueducts, and roads, exhibit the mastery he had acquired, and his conquests over nature. Frontinus, whose work on aqueducts was written about the year 80, has a passage remarkably illustrative of the growth of this spirit in his time. After giving a description of the nine aqueducts under his care, brought to Rome by successive labours, making an aggregate length of about 142 miles, he exclaims, "with so many waters, and so many magnificent works necessary for their transport to this great city, will you compare the idle Pyramids of Egypt, or even the inert works of the Greeks, however celebrated and glorious in his ory?" The ingenuity of the architect now, therefore, issues to use, and through 1800 years it is more or less subordinate to it, either in the great business of religious and moral improvement in the building of churches, or the security of civil life in castles and mansions. Finally, in recent times, it is contracted to absolute utilitarianism, and all its powers are bent to the perfection of the individual dwelling between party walls, in which every subject of the state is in the enjoyment of personal luxuries and conveniences of life unknown to the Pharoahs, the Medici, or the magnificent Louis the Fourteenth.

Thus, as Monsieur Guizot finely observes, each age and nation seems to have flourished for some beneficial purpose to Mankind, which, being accomplished, it disappears from the stage.

The history of architecture may be said to divide itself into five classes—Sacred, Civil, Military, Domestic, and Monumental. In the accompanying drawing (a roll about twelve feet square, containing a vast group of buildings inscribed within the outline of a pyramid, on a large scale) are seen indiscriminately some of the principal monuments of all these classes (except the military), comprising a period of 3,334 years. We may say to the students, in the words of Napoleon to his troops, before the Pryamids of Gizeh" Quarante siècles vous contemplent!"

This arrangement done under the Professor's direction, about twenty years ago, appeared, he believed, for the first time in the Penny Magazine. A comparative view of the great buildings of the earth, on the same scale, might minister to that false estimate of merit, which is derived from material dimension; but that criterion would vanish before the comparison of renown; and the Parthenon, and other small buildings, here represented, would abundantly illustrate the preference to be awarded to

The little body, but the mighty soul.

National attachment might excuse his pointing out the spire of Old St. Paul's, the only one exceeding the height of the Great Pyramid. Those of Mechlin and Cologne, though designed to have exceeded it, remained imperfect. A limit seems to be placed to man's arrogance and vain glory. We were taught, like the Babylonians, that the God of nature delights not in the accumulation of his favours and his light, and isolated in single spots, but in the wide-scattered communication of them throughout all lands.

But the observations already offered, were illustrated still further by the sections [on a roll as large as the former, showing the structure of the most important temples, on the same scale.] The issue of the art in use and economy, was most remarkably shown in the comparison of those sections, in which we observe, that St. Paul's displays the largest bulk with the least material, hitherto contrived.

He should now call the attention of the students to two rolls [about 16 feet long each], in the first of which the plans of the remarkable temples of the ancient world, from the Tabernacle in the Wilderness (1491 B.C.) to the reception of Christianity (313 A.C.), and in the second those from that epoch down to 1842, were all laid down to the same scale. There was displayed, as it were, the genealogy of temples, during 3330 years.

It was sacred architecture which he purposed to review cursorily that evening; and short enough was the time for a subject so deeply interesting; indeed, such an expression might be deemed presumptuous; and it was obvious that we should be enabled to do no more than pass the plans in review, and remark upon those characteristics which became the more palpable on the synoptic view of centuries and ideas of such extent and variety; and which were less frequently commented upon. It might be objected by the students that subjects of such vast scale and importance and rare occurrence should be illustrated, rather than the more practical; but we should remember the dictum of Vitruvius, that the architect ought to pursue his studies "maxime in ædibus Deorum, in quibus operum laudes et culpæ æternæ solent permanere." In fact, the remains of these precious exemplars of skill and cost and labour, the types of our art, were still discoverable even from the most remote times, as if Nature herself, as well as man, had respected them.

In approaching sacred architecture, and in discussing the technical considerations of the forms and structures of temples, we cannot but bow with respect and veneration to those motives and affections, the noblest of the human heart, which have ever urged these sacrifices to the mercy and the majesty of the Creator—and we recognize in the Grecian or the Druid, the Hindoo or the Christian temple, the universal sentiment so finely expressed in the Psalms, CXXIX:—

"Lord, remember David and all his trouble!

"How he sware unto the Lord, and vowed a vow unto the mighty God of Jacob,

"I will not come within the tabernacle of mine house, nor climb up into my bed,

"I will not suffer mine eyes to sleep, nor mine eyelid to slumber, neither the temples of my head to take any rest, "Until I find out a place for the temple of the Lord, an habitation for the mighty God of Jacob."

In excavating the foundations of the temple at Ægina, the remains of burnt woods and bones of sacrifices were discovered, mixed, no doubt, with libations and tears and aspirations as warm as those of David;—at Selinus we find the steps in front of one of the temples worn down almost to an inclined plane, by the feet of the devout. So again of the accomplishment of these vows amongst men of all ages and nations, we shall find the most solemn and full expression in the eighth chapter of the First Book of Kings, the dedication of the temple by Solomon.

The resemblance of the plan of the Tabernacle in the Wilderness, and with its surrounding court (the first in our series, B.C. 1491), and still more, of the temple of Solomon; with the arrangement of the Greek and Roman temple, down to the Antonines at the end of the second century of our era, is very remarkable. In the first the parallelogram is preceded by a portico of an irregular number, namely, of five columns. In the second (1012 B.C.) we have the temple in Antis.

If we enter into particulars, we are still more struck with their correspondence; we find for instance, the irregular number in the temple of Jupiter at Agrigentum, one of the largest and most important of antiquity: seven columns compose the front; and we are reminded of Solomon's saying, (Prov. ix.) "Wisdom has builded her house, she has hewn out her seven columns." Again, at Pœstum we have a temple (miscalled a basilica) with nine columns in the front. Other examples also might be cited. Again, of the Temple of Solomon, that of Themis at Rhamnus, and the frequent temple in Antis, with its pronaos and heiron, is the constant copy. The altar of sacrifice, that of incense, the laver, the table of shew-bread, are all traced either in existing remains, in bas-reliefs, or in medals.

The connexion of classic and sacred architecture is thus apparent; and the author of "The Plagiarisms of the Heathen Detected," (Mr. Wood, of Bath,) is borne out in this comparison of the *plan and arrangement* of temple architecture. The common error (and one to be carefully avoided) is the attempt to trace this resemblance in *the styles*, or the ichnographic figure of the parts and orders—the mere vesture of the scheme; and the failure in straining the texts and examples (Corinthian or Doric) to a perfect correspondence, either in Wood, Villalpandus, or his learned predecessor, Wilkins, has always thrown a doubt upon these interesting investigations; but the comparison of the *plans* makes the Tabernacle the type of the Greek and Roman temple, a work which Paul as well as Moses assures us was inspired by the Deity, "for see, saith he, that thou make all things according to the pattern showed thee in the mount." (Heb. viii.)

It is remarkable that the earlier or contemporary works of Egypt show no similar arrangement; nor was it likely that Moses should adopt and recommend any form associated with Egyptian recollections. The circular form of plan is indeed traced in Greece, and Rome more especially, and amongst the Druids, but the most frequent by far is the parallelogram, after the Tabernacle: in fact, the earliest inhabitants of the bordering countries were apparently monotheists; their connexion with the Jews through Tyre and Sidon, their respect for a people of superior knowledge and religious instruction, may well have sanctified their form with them: the ritual was the same with them; the idol took the place of the ark; with both, the temple was the Domus Dei; both were religions of sacrifice.

The ritual was thus the originator of the form of the temple, and must always be so. The temple in Antis became (with a view to ornament, and by the successive inventions for decorum and dignity) the prostyle, peripteral, dipteral, and pseudo-dipteral. The much-boasted beauty of the Greek temple was not, then, an invention of taste, but one of ritual; and in the consideration of templar architecture, in all times and countries, this important fact must be carefully bore in mind.

Another point of resemblance of classical and Jewish architecture, of great import, since it is the hinge upon which the whole system of ancient architecture turns, is the employment of "costly stones, even great stones, stones of ten cubits, stones of eight cubits." Upon this practice the whole character and taste of sacred and classical architecture depends. The tenth book of Vitruvius treats chiefly on large stones and their transport. The type of Domus Dei admitted of no extension; the only mode of giving magnificence and dignity to temples, thus circumscribed in form and composition, was by the employment of monolithic masses, and by the exquisite detail of proportion, order, and sculpture bestowed upon them. The ancient world is full of examples of this remarkable principle, and the last and most signal one is that in the temple at Balbec, by the Antonines, in which three stones measure, in the aggregate, upwards of 199 feet in length.

The Saviour, whose religion was soon to supersede all ancient laws, constantly illustrates his arguments by this practice: "the head stone, the chief of the corner, which the builders rejected," are his constant metaphors; and his prediction that of these great stones "there shall not be left one upon another," is literally verified in the subsequent history of Architecture.

Our remarks upon the uniform arrangement of plans of Greek and Roman temples, would be too long, and must be referred to the publications upon them specifically; but as brought together in this view it may be observed, that the temple at Ephesus, the size of which we learn alone from Pliny, exceeds all others in dimensions, and the constant limitation of length of the great temple to Jupiter especially (at Athens, Agrigentum, Selinus, Balbec, and Rome) to about 358 feet in length, might lead us to suspect the text of Pliny. Vitruvius gives us a few hints of the attachment of the ancients to numbers in his third book, with reference to the dimensions of temples. The investigation of this subject might be attended with curious results. The frequent dimension 358, by the addition of the stylobate, or by the local variation of the foot, may easily be supposed to refer to the number of days in the solar year. In the Temple or the Sun at Palmyra, the portico has 12 columns; these, added to the columns in the temple, make 52; the whole number of columns in the surrounding peribolus, is 364. Wren seems to have had reference to this idea in his height of St. Paul's.

The sections of Ægina, the Parthenon, and the temple at Pœstum, exhibit the arrangement of an interior divided into a nave and two ailes, by two rows of columns in double heights; those of Venus and Rome, and Balbec, exhibit the Roman form, namely, a vast vault—in these instances, upwards of 60 feet diameter in masonry. The occupation of the whole of these interiors by the idol, their employment as a vast niche to receive the god (in ivory and gold, at Olympia and Athens), had something of monstrous, but magnificent; and invested with the art of Phidias, we may understand how even the rough soldier, Paulus Æmilius, might be moved even to tears, as we are told, in the presence of the beauty and majesty of the godhead, as figured by that great master.

Arrived at that period (313 A.D.) in which the Christian religion was adopted by the state, the range of temples now exhibited displays a total reverse of the previous arrangement. The old ritual of external worship and of sacrifice was abrogated. It was now internal and of the heart; the portions were now inclosed; a vast area covered with a roof, of which the basilica was the best model, constituted the Christian temple. Upon this the cruciform was engrafted, "in hoc vince," bearing the universal symbol, in plan as well as in every other situation. The theory of the church of Constantine is handed down to us by Eusebius, bishop of Cæsarea; he describes the church of Tyre [which the Professor exhibited] and many others of his day, with the most interesting and instructive hints as to the signification and arrangement of sacred edifices, which may be very profitably consulted by the architect. The basilicas of St. Peter's and that of St. Paul's at Rome, in the form of the Latin cross, become the types of the Christian church throughout Western Europe, with very small variation (until the introduction of the dome, which then only modified it), down to the present day.

It was said that 1800 churches and religious structures were built during the reigns of Constantine and Justinian: those of the former were in the basilica form, which is liable to decay; those of the latter, to which the ritual and other important considerations gave a new form, resembled the Greek cross of equal lengths. The transept was covered with a large dome, and the ends of the cross with minor ones, forming a group highly favourable to architectural effect. This form, executed in Santa Sophia, became the wonder of the world, and the dome also, 120 feet in diameter, exceeded any executed since the Pantheon at Rome.

The Professor exhibited several Greek churches at Arta, Thessalonica, and other parts of Greece, measured by himself, as also the valuable researches on the Greek church architecture of the sixth and seventh centuries, by M. Couchaud, which contained many hints of great beauty and interest to the practical architect. The churches of Russia were all upon this plan. Procopius was the author, who might be consulted with reference to this era of the art.

The dome, which had become the distinguishing feature of the Eastern church, penetrated into Italy, under the exarchate at Ravenna, in the church Santa Vitali, 510 A.D; and again at Venice, in St. Mark's, built by a Greek architect (976—1071). Until the eleventh century, the dome formed no part of the western church, except in those instances; it was then that the Pisans, the richest and most commercial people of Italy, began their great church (1063), and adorned the transept with this new feature.

The rivalry of nations is the great fulcrum of many a noble effect, in arts as well as politics; and to this motive chiefly, we may attribute the bold scheme of Arnolpho de Lapo, in the church of Santa Maria, at Florence, founded in 1290; in which, doubtless, after the model of the Pantheon, he proposed to place a dome, of nearly equal magnitude, over the transept, but raised into the air in a way hitherto unattempted, except at Constantinople, where, however, the space was one-sixth smaller. But the inveterate and disastrous contests of these republics long deferred the execution, and it was not till one hundred and twenty years after, that Brunelleschi accomplished the work, as related in the very amusing and instructive account by Vasari.

It was just one hundred years after this successful work that Michael Angelo executed the dome at St Peter's, confessedly in imitation of it, as he told himself, in contemplating the model—

Vó far la tua sorella,
Piú grande giá, ma son piú bella.

In another one hundred and fifty years, we have the Domes of the Invalides, Val de Grace, at Paris, and St. Pauls, in London.

The family of Domes concludes with that of St. Genevieve (the Pantheon), and, like the successor of a noble but a worn-out race, exhibits all that meagreness and debility which precedes its extinction.

But the imitations of the types of the basilicas of St. Peter's and St. Paul's of Rome in the north and west of Europe,—*more Romano* to the eleventh century, from the eleventh to the sixteenth centuries *more Germanico*, by the societies of Freemasons,—have justly been the admiration of the world, for their unexampled hardihood and practical science, though the remarks on their principles of structure and of art, which the future lectures will have occasion to offer, will show that neither the geometrician nor the scientific architect need regret the impenetrable veil which conceals them. Any detailed discussion of the merits of the plans exhibited would lead beyond the bounds prescribed; but we must admit that, generally, the continental plans exceed our own in magnificence of design, especially in the double ailes and the western fronts. To what causes may be assigned the more modest design of our own churches, except to that characteristic prudence of our countrymen, which requires the full accomplishment of every enterprise undertaken, it may not be easy to determine; certain it is, that all the churches of this country are complete in their design and features, whereas those of the continent are very rarely so.

The words of our poet, though not always applicable to architects, unhappily, may be so to our pastors and masters.

> When we mean to build, we first survey the plot,
> Then draw the model: which if we find exceeds ability,
> What do we then, but draw anew the model in fewer offices.
>
> ——— Consult surveyors, know our own estate,
> How able such a work to undergo.
> Or else we build like those, who half thro' give o'er,
> And leave their part created cost
> A naked subject to the watery clouds,
> And waste for churlish Winter's tyranny.

With reference to the gradual verticality which the sections of this series of ancient and modern temples assumed, we might say, that the earliest were of the earth earthy, and the latter as sublime as the religion for which they were designed. Thus, the height of the Pantheon, at Rome, was equal to its diameter, or as 10 to 10; that of Venus, and Rome, was as 12½ to 10; that of the Baths of Caracalla, as 14 to 10; of St. Peter's, at Rome, as 17 to 10; of St. Paul's, London, 20 to 10, as also of Lincoln; and that of Cologne was as 34 to 10.

The last great temple of Christendom, was the Magdalene Church at Paris; it is 325 feet long by 136 feet wide and 120 feet high, and equalled the smaller temple at Balbec. It was the work of more than half a century. In England, great activity had been used in church-building during the last twenty-five years, but the warmest admirers of those zealous efforts could never pretend that any regulated architectural spirit has directed those works. No church of a monumental character had been attempted. The ascendancy of the high church party is, however, favourable to our art, and it is not unlikely, that under good direction, it may flourish in a few years. But there is much pedantry abroad, and an absence of all originality and intrinsic character in the taste of the day, which leans to the Roman Catholic form, the basilica, suited to a demonstrative form of worship, rather than the auditorium required by our ritual. Veneration for antiquity is to be respected and encouraged, but its transition to superstition is easy. The divines of 1680 have left us models, erected under the direction of Sir C. Wren, which have not been surpassed. Seven of the city churches were exhibited (measured by the Professor), which would be found as remarkable for their adaptation to our form of worship—offering the largest area, with the smallest obstruction to the sight and hearing,—as they were ingenious and admirable in taste and structure.

The favourite design of Sir C. Wren (laid down from the model now in St. Paul's,) was also exhibited. It was a precious legacy to posterity, which had never been surpassed in architectural beauty and arrangement, for the Anglo-Protestant Cathedral church, and would probably at some future time be executed.

But attachment to our national architecture may be indulged with great propriety by the adoption of the forms of the Lady Chapels, modified and suited to our ritual—as those of Wells, Ely, and others; or of the chapter-houses; and the Greek church. The basilica form requires length unsuited to our services, and the fragments or curtailed portions of that form, often practised with small success in our recent churches, seems to point at the greater advantage of the vertical arrangement, which the models, the Professor ventured to suggest, in the churches of Wren, and the examples quoted, would assure to us.

THE METROPOLITAN PAVING ACT.

An important case came before Mr. Hardwick at the Marlborough Police Office, on the 24th of December last, arising out of a dispute between the Equitable Gas Company and the Commissioners of Paving for the parish of St. James's, Westminster, as to whether the Equitable Gas Company had or had not the right of breaking up the street and afterwards lay down a service pipe "without the consent of the Paving Board." After hearing both parties, the Magistrate adjourned the case for consideration until Thursday, January 5th, when it was again heard for final adjudication.

Mr. Smith, solicitor, attended on behalf of the Paving Commissioners, and Mr. Clarkson, the barrister, for the Equitable Gas Company.

Mr. Hardwick read the following as his opinion:—This is a complaint by the Board of Pavements, in the Parish of St. James, against the Equitable Gas light Company, for breaking and taking up the pavement in their jurisdiction for the purpose of laying down a new pipe without the consent of the board. The answer of the Gas Company is, that it being a service pipe and not a main pipe, a notice only and not the consent of the board is required. The clauses which gave rise to the disputed point are in the 11th section of the 57th George III, cap. 29. Abridged they stand thus—"No water or gas light company shall break or take up the pavement in any street for the purpose of laying down any main or mains of pipes, unless notice in writing be given to the surveyor of pavements three days previous to such breaking up," &c. So far water and gas companies are placed upon the same footing; but in the next clause a further restriction is imposed on gas companies. By it no gas company can take or break up any pavement for the purpose of laying down any new mains or pipes without the consent in writing of the Board of Pavement. When my attention was first called to this clause, my impression was, that being, as it then seemed to me, in the disjunctive, the word "pipes" must be taken to include pipes of every description, and that the Board of Pavement was right in their view of the case. But on a more attentive perusal of this section, and especially of the following one, that impression has been much removed; and I am now inclined to think that the perplexity in this matter has arisen from an ambiguous use of terms, from using different expressions to signify one and the same thing; for example:—In the beginning of the 12th section, which directs of what materials mains should be, the language there used is worthy of observation. "That all new or complete mains, or pipes laid down in any street by any water or gas company, whether such new or complete main of pipes shall or shall not be substituted for, or added to, any other complete main or mains of pipes, shall be of iron alone." Here in these few lines we have three different expressions—mains, or pipes, main of pipes, and main or mains of pipes, all signifying one and the same thing—the main pipe. In the next clause separate and distinct mention is made of service-pipes, which may be either of iron or lead, or other durable material; from which I am induced to infer that, possibly, "or" is a typographical error for "of," or at any rate it is to be taken in a disjunctive sense, but, as it is frequently used, expressing an alternative of terms, a definition or explanation of the same thing in different words. Thus "main" being purely a technical word of the most comprehensive signification, the terms "pipes" and "mains of pipes" have been added and used as an alternative term to give it a clearer and more definite meaning for the purposes of this act, and therefore the expression "mains or pipes," in the clause under discussion, may not unfairly be read as synonymous with "mains of pipes," or pipes forming the main. If this should be the right view of the case, the complaint must be dismissed; as the pipe in question laid down is a service, not a main pipe, it requires notice only, not the consent of the board.

Mr. Smith argued that the 11th section of the act of Parliament related both to main and service pipes, whether they were for gas or water companies.

Mr. Hardwick said this question only applied to mains.

After a long discussion, Mr. Hardwick said he still adhered to the conclusion he had just read.

Mr. Smith observed, that unless there was a conviction before the magistrate, he had no power of appeal.

Mr. Hardwick said the proper court of tribunal was the Court of Queen's Bench.

Mr. Clarkson had waited very patiently while this discussion was going on. He was, however, very much surprised to hear [that Mr. Smith had displayed so much ignorance with relation to the decision of those whom he (Mr. Clarkson) was proud to call his learned friends—viz., the present Attorney-General (Sir F. Pollock), or former Attorney-General (Lord Campbell), Mr. Adolphus, and another learned friend, all of whom had given opinions quite contrary to that which Mr. Smith now stood upon. He contended that the mains having been laid down at the house of any person applying, common law and common sense gave him the power, which the law of England gave every man, of having his own subsoil opened. He did not know whether it was, as the worthy magistrate had observed, a typographical mistake in the act of Parliament in substituting "or" for "of," or one of those tinkerings which he had so frequently observed in the machinery of acts of Parliament, but he must say the act was most defective. It was wind without sense; sometimes the word "mains" was used, and sometimes "pipes;" they were "*ejusdem generis.*" What a state of things it would be, if a collector was to come to a person who wished his gas to be laid on in the front of his house, and say he did not like his look; or, if another was to be asked to lay on the water, to say he did not admire his politics. Would such proceedings be tolerated? He was certain not. The tenant, the drains having been laid down, had a right to open the subsoil, and in his opinion he was fortified by the opinions of the eminent legal authorities he had mentioned. A similar case had been argued before Mr. Long by himself and his learned friend Mr. Bodkin, and the learned magistrate had, in that case, decided, notwithstanding all his learned friend's arguments, against him and the parochial commissioner.

A discussion was here raised between Messrs. Clarkson and Smith, as to whether or not notice had been given on the 11th of May by one of the inspectors of the gas company of his intention to open the street; Mr. Clarkson denied that such notice had ever been given.

Mr. Hardwick considered that, by the arguments which had been brought before him, and also by his own previously written opinion, the gas company were authorized to open the ground for service-pipes: the complaint was therefore dismissed.

REVIEWS.

An Encyclopædia of Architecture, Historical, Theoretical, and Practical. By JOSEPH GWILT. Illustrated by more than 1000 engravings on wood. In one thick volume, 8vo., 1080 pp. London, 1842. Longman & Co.

SECOND NOTICE.

WE may resume our notice of this work, by remarking that Mr. Gwilt indulges almost quite as much in criticism upon "critics," as upon buildings, and that as regards the former, he is apt to express himself with a degree of spleen against the whole race, that amounts to want of temper, and which certainly is not calculated to obtain for him their good word. Nevertheless, his present work has obtained unqualified, not to call it outrageous praise, from some of them; viz., those who write for newspapers, and in whose favour he is henceforth bound to make an exception. Most good-natured they certainly must be allowed to have shown themselves—that is, supposing they looked far enough into his book to meet with some of the ungracious reflections he has thrown out upon the fraternity of reviewers. Although not very thin-skinned ourselves, nor disposed to vindicate the pretensions of all our reviewing brethren, we must say, that Mr. Gwilt carries his hostility too far. He takes it for granted, that none of those who write upon architectural subjects in literary journals, are professional men, or if not belonging to the profession, can have qualfied themselves by study, for the task they venture upon. Were the "catalogue of works on architecture," which he has given in his Encyclopædia, what it ought to be, it would contain many, and those not the least interesting or valuable of all, for which we are indebted to the studies of those whom Mr. G. would have us regard as little better than intruders and pretenders—persons who just know enough of the subject to assume a tone of authority, and mislead others. Since he has not thought proper to insert in that "Catalogue," such works as Hope's History of Architecture, Parker's Glossary, (now considered as a sort of authority,) and the publications of Rickman, Whewell, and Willis—not to mention others, which he has omitted; we must suppose that he estimates them not at all higher than the effusions of anonymous scribblers and reviewers, although they have obtained some character not only with the public, but with the profession also. What may be his standard of merit—where he has drawn the line between works that are, and those which are not worthy of being recommended to the student, we are unable to say, for he seems to be just as over-liberal and indulgent in some instances, as he is vigorous in others. Among the publications enumerated under the head of modern English architecture, we do not find the "Public Buildings of London," or Malton's "Picturesque Tour," which last, though not professedly architectural, as it contains only views, is an exceedingly interesting graphic work. Neither are Robert Adam's designs there mentioned, although those of James Lewis, a far less distinguished architect, are. Neither is Barry's "Traveller's Club House" inserted, notwithstanding that both the building itself is considered a tolerably favourable specimen of English architecture at the present day, and is more fully illustrated than almost any other individual edifice, exceping Holkham.

That these remarks are rather ungracious, and not likely to prove altogether palatable to Mr. Gwilt, we do not deny; but many of his own remarks are so exceedingly ungracious and illiberal, that he has no right to look for much forbearance on the part of others. Even while we are willing to give him credit for having the interests of architecture at heart, we think he has altogether mistaken the way in which they are to be promoted. Instead of expressing any satisfaction at finding that architecture now begins to excite far more attention than it used to do, he takes no pains to conceal his disapprobation of its being taken up as a mere pursuit, by those who do not apply to it professionally; which is almost tantamount to saying, that those who have a taste for the study, have no right to indulge in it, and to acquire that knowledge of the art, which is indispensably requisite, if they would really enjoy it, and become capable of judging of its productions:—which is certainly strange doctrine, and is so completely contrary to all views of sound policy, that, never, it is to be hoped, will it be adopted. Of that, however, we have little apprehension; were it ever so desirable, it is now too late to attempt to check what is, if not a rapidly advancing, a widely spreading taste. Far more reason is there to apprehend that the prejudices to which Mr. G. has given way, will raise up some prejudice against his own book: at all events, they are not calculated to obtain him good-will. And though on our own part we might have abstained from adverting to this characteristic of his Encyclopædia, we should have felt that by so doing, we were deserting the cause of architecture and its friends, and by our acquiescent silence, abandon many who have rendered important services to that cause, to the odium attempted to be thrown upon them by Mr. Gwilt.

To return to the volume itself: the more popular portion of it, namely, the historical, is by no means so full as it ought to be, and might have been, had space been obtained for that purpose, by omitting elsewhere a great deal of matter which there was not the least occasion to introduce at all. Of the architecture of many parts of the Continent, we meet with only hasty sketches, without any specimens of their buildings; and even the history of Italian architecture is cut short very abruptly, being brought down only to the beginning of the 17th century, as if the following and the present one had produced nothing of the least note. Yet some mention of Calderar and his works, if of no one else, might have been expected, from a professed admirer of the Palladian school, as Mr. G.

Of a work of this nature, it is hardly possible to convey a suitable idea by extracts or detached passages; nevertheless, we give those in which the characteristicts of the Florentine, Roman, and Venetian schools are spoken of, and respectively illustrated by an example.

"*Florentine School.*—Climate and the habits of a people are the principal agents in creating real style in architecture; but these are in a great measure controlled, or it is perhaps more correct to say modified, by the materials which a country supplies. Often, indeed, these latter restrict the architect, and influence the lightness or massiveness of the style he adopts. The quarries of Tuscany furnish very large blocks of stone, lying so close to the surface that they are without other difficulty than that of carriage obtained, and removed to the spots where they are wanted. This is probably a circumstance which will account for the solidity, monotony, and solemnity which are such commanding features in the Florentine school; and which, if we may judge from the colossal ruins still existing, similarly prevailed in the buildings of ancient Etruria. In later times another cause contributed to the continuation of the practice, and that was the necessity of affording places of defence for the upper ranks of society in a state where insurrection continually occurred. Thus the palaces of the Medici, of the Pitti, of the Strozzi, and of other families, served almost equally for fortresses as for palaces. The style seems to have interdicted the use of columns in the façade, and on this account the stupendous cornices that were used seem actually necessary for the purpose of imparting grandeur to the composition. In the best and most celebrated examples of their palaces, such as the Strozzi, Pandolfini, and others in Florence, and the Picolomini palace at Sienna, the cornices are proportioned to the whole height of the building considered as an order, notwithstanding the horizontal subdivisions and small interposed cornices that are practised between the base and the crowning member. The courts of these palaces are usually surrounded by columns and arcades, and their interior is scarcely ever indicated by the external distribution. From among the extraordinary palaces with which Florence abounds, we place before the reader the exquisite façade of the Pandolfini palace, the design whereof (Fig. 1,) is attributed to the divine Raffaelle d'Urbino. In it almost all the requisites of street architecture are displayed. It is an example wherein the principles of that style are so admirably developed, as to induce us to recommend it, in conjunction with the façade of the Farnese palace hereafter given, to the elaborate study of the young architect.

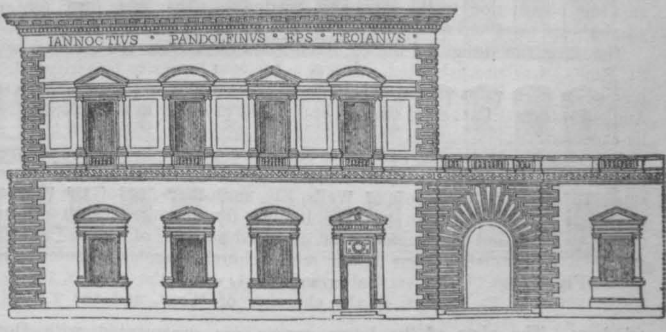


Fig. 1 PANDOLFINI PALACE.

"*Roman School.*—Though the city of Rome, during the period of the rise and progress of the Roman school of architecture, was not altogether free from insurrectionary troubles, its palatial style is far less massive than that of Florence. None of its buildings present the fortress-like appearance of those in the last-named city. Indeed, the Roman palaces, from their grace and lightness, indicate, on the part of the people, habits of a much more pacific nature, and an advancing state of the art, arising from a more intimate acquaintance with the models of antiquity which were on every side. The introductions of columns becomes a favourite and pleasing feature, and great care and study appear to have been constantly bestowed on the façades of their buildings; so much so, indeed, in many, that they are but masks to indifferent interiors. In them the entrance becomes a principal object; and though in a great number of cases the abuses which enter into its composition are manifold, yet the general effect is usually successful. The courts in these palaces are most frequently surrounded with arcades, whence a staircase of considerable dimensions leads to the sala or principal room of the palace. The general character is that of grandeur, but devoid altogether of the severity which so strongly marks the Florentine school. The noblest example of a palace in the world is that of the Farnese family at Rome.

"The palaces of Rome are among the finest architectural works in Europe; and of those in Rome, as we have before observed, none equals the Farnese, whose façade is given in Fig. 3, 169. "Ce vaste palais Farnese, qui à tout prendre, pour la grandeur de la masse, la regularité de son ensemble, et l'excellence de son architecture, a tenu jusqu'ici, dans l'opinion des artistes, le premier rang entre tous les palais qu'on renomme," is the general description of it by De Quincy, upon whom we have drawn largely, and must continue to do so. This edifice, by San Gallo, forms a quadrangle of 256 feet by 185 feet. It is constructed of brick, with the exception of the dressings of the doors and windows, the quoins of the fronts, and the entablature and loggia in the Strada Giulia, which are of travertine stone. Of the same stone, beautifully wrought, is the interior of the court. The building consists of three stories, including that on the ground, which, in the elevations or façades, are separated by impost cornices. The only break in its symmetry and simplicity occurs in the loggia, placed in the centre of the first story, which connects the windows on each side of it by four columns. On the ground story the windows are decorated with square-headed dressings of extremely simple design; in the next story they are flanked by columns, whose entablatures are crowned alternately with triangular and circular pediments; and in the third story are circular-headed windows, crowned throughout with triangular pediments. The taste in which these last is composed, is not so good as the rest, though they were probably the work of Michael Angelo, of whose cornice to the edifice Vasari observes:—"E stupendissimo il corniccione maggiore del medesimo palazzo nella facciata dinanzi, non si potendo alcuna cosa ne più bella ne più magnificà desiderare." The façade towards the Strada Giulia is different from the other fronts in the centre only, wherein there are three stories of arcades to the loggia, each of whose piers are decorated with columns of the Doric, Ionic, and Corinthian orders in the respective stories as they rise, and these in form and dimensions correspond with the three ranks of arcades towards the court. It appears probable that this central arrangement was not in the original design of San Gallo, but introduced when the third story was completed. Magnificent as, from its simplicity and symmetry, is the exterior of this palace, which, as De Quincy observes:—"est un édifice toujours digne d'être le sejour d'un prince," yet does it not exceed the beauty of the interior. The quadrangle of the court is 88 feet square between the columns of the arcades, and is composed with three stories, in which the central arrangement above mentioned towards the Villa Giulia is repeated on the two lower stories, over the upper whereof is a solid wall pierced in the windows. The piers of the lower arcade are ornamented with Doric columns, whose entablature is charged with triglyphs in its frieze, and its metopæ are sculptured with various symbols. The impost of the piers are very finely profiled, so as to form the entablatures, when continued, over the columns of the entrance vestibule. In the Ionic arcade, over this, the frieze of the order is decorated with a series of festoons. The distribution of the different apartments and passage is well contrived. All about the building is on a scale of great grandeur. Though long unoccupied, and a large portion of its internal ornaments has disappeared, it still commands our admiration in the Carracci Gallery, which has continued to serve as a model for all subsequent works of the kind. The architecture of the Farnese palace, more especially as respects the arcades of its court, is the most perfect adaptation of ancient arrangement to more modern habits that has ever been designed. We here allude, more particularly, to the arcades, upon whose piers orders of columns are introduced. This species of composition, heavier, doubtless, less elegant, yet more solid than simple colonnades, is, on the last account, preferable to them, where several stories rise above one another. The idea was, certainly, conceived from the practice in the ancient theatres and amphitheatres; and in its application at the Farnese palace rivals in beauty all that antiquity makes us in its remains acquainted with. San Gallo, its architect, died in 1546."

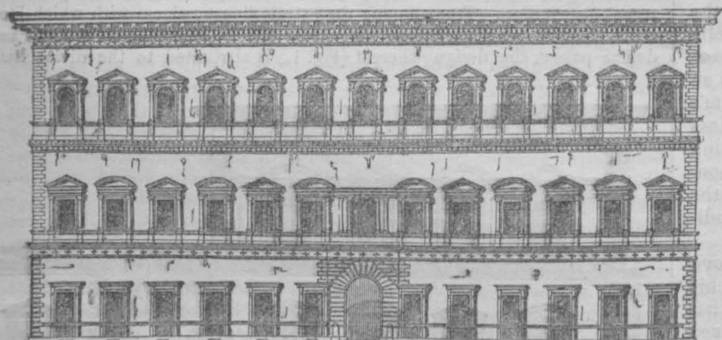


Fig. 1. FARNESE PALACE.

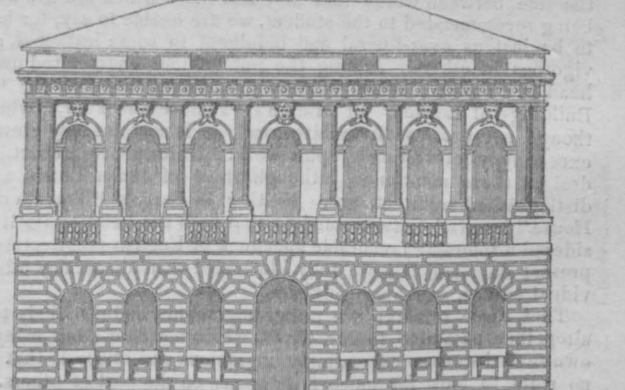


Fig. 2. POMPEI PALACE, VERONA.

The Venetian school is spoken of at much greater length than the others, and is, in our opinion, not a little over rated; for when we come to examine some of its most noted productions, we find them to be made up of insignificant parts, and petty orders treated in a formal, dry, and meagre manner, without any of that richness, or of that artist-like freedom, which would reconcile us to the orders being employed merely in half-columns and pilasters, as decorated to one or more stories of a building.

"*The Venetian School* is characterised by its lightness and elegance; by the convenient distribution it displays; and by the abundant, perhaps exuberant, use of columns, pilasters, and arcades, which enter into its composition. Like its sister school of painting, its address is more to the senses than is the case with those we have just quitted. We have already given an account of the church of St. Mark, in the 12th century; from which period, as the republic rose into importance by its arms and commerce, its arts were destined to an equally brilliant career. The possession in its provinces of some fine monuments of antiquity, as well as its early acquaintance with Greece, would, of course, work beneficially for the advancement of its architecture. That species of luxury, the natural result of a desire on the part of individuals to perpetuate their names through the medium of their habitations, though not productive of works on a grand or monumental scale, leads, in a democracy (as were the states of Venice), to a very general display of moderately splendid and elegant palaces. Hence the extraordinary number of specimens of the building art supplied by the Venetian school.

"San Micheli, who was born in 1484, may, with propriety, be called its founder. Having visited Rome at the early age of 16, for the purpose of studying its ancient monuments of art, and having in that city found much employment, he, after many years of absence, returned to his native country. The mode in which he combined pure and beautiful architecture with the requisites called for in fortifications may be seen displayed to great advantage at Verona, in which city the *Porta del Pallia* is an instance of his wonderful ingenuity and taste. But his most admired works are his palaces at Verona; though, perhaps, that of the Grimani family at Venice is his most magnificent production. The general style of composition, very different from that of the palaces of Florence and Rome, is marked by the use of a basement of rustic work, wherefrom an order rises, often with arched windows, in which he greatly delighted, and these were connected with the order after the manner of an arcade, the whole being crowned with the proper entablature. As an example, we give in Fig. 3, the façade of the Pompei palace at Verona. The genius of San Micheli was of the very highest order; his works are as conspicuous for excellent construction as they are for convenience, unity, harmony, and simplicity, which threw into shade the minor abuses occasionally found in them. If he had no other testimony, it would be sufficient to say, that for his talents he was held to be in great esteem by Michael Angelo; and our advice to the student would be to study his works with diligence. San Micheli devoted himself with great ardour to the practice of military architecture; and though the invention was not for a long time afterwards assigned to him, he was the author of the system used by Vauban and his school, who, for a long period, deprived him of the credit of it. Before him all the ramparts of a fortification were round or square. He introduced a new method, inventing the triangular and pentangular bastion, with plain fossés, flanks and square bases, which doubled the support; he moreover not only flanked the curtain, but all the fossé to the next bastion, the covered way, and glacis. The mystery of this art consisted in defending every part of the inclosure by the flank of a bastion; hence, making it round and square, the front of it, that is, the space which remains in the triangle, which was before undefended, was by San Micheli provided against.

In this example of San Micheli's style, the Palazzo Pompei at Verona, the basement is the best part of the composition, for the order is too small in proportion to the rest, and the openings on the principal floor as much too large, at least as windows, for the piers between them must be most inconveniently narrow within. It is rather singular, that while he was upon the subject of Italian architecture, Mr. Gwilt should not have alluded to the recent introduction of the *palazzo* style, in this country. As an example of it, he gives the façade of the Palazzo Pandolfini at Florence, strongly recommending that and the Palazzo Farnese, to the "elaborate study of the young architect," but without informing him, that by going into Pall Mall, he would perceive what use had been made both of the one and the other, by Mr. Barry, in the two adjoining club houses—the Travellers and the Reform. Though neither copies nor even imitations—in the ordinary meaning of the term, they are evidently borrowed from those prototypes, which in point of mere taste, are there improved upon and refined. The Reform Club House has been spoken of, by some, as being a direct copy of the Farnese; with what justice or judgment, may be seen from the above representation of the latter, which though too small to do more than afford an idea of the general composition, shows the manner in which the entrance and window on each side of it are squeezed together, produces anything but an agreeable effect; while the centre window above, exceptionable in character at the best, is, so introduced as to constitute a striking blemish in the whole design.

We must now take leave of Mr. Gwilt's work, which we should have been happy to have been able to speak of in less qualified terms of approbation. It contains a great deal of valuable, but not so much fresh matter as it might have done; but it also contains many opinions which we should be the last to support, and which are not likely to gain ground with the public, at the present day. We cannot, however, conclude, without expressing our high approbation of the spirited manner with which the publishers have got up the work, both in the typography and illustrations; the latter are beautifully executed as wood, or may be seen by the above specimens, which we have been permitted to select from the work.

Ensamples of Railway making; which, although not of English practice, are submitted, with Practical Illustrations to the Civil Engineer, and the British and Irish public. London: Architectural Library, 59, High Holborn.

The great disparity between the cost of railways in this country and that of similar works in America, is worthy at the present time of giving rise to some important considerations. Whilst on this side of the Atlantic, our main lines of railway have been constructed of materials extremely durable, in a manner remarkable for strength and solidity, and according to a standard of excellence with respect to gradients, which far surpasses any thing that has been attempted under like circumstances in other countries, the policy of absorbing such vast sums of money as have been required to effect all this is at least open to controversy. Hitherto every thing has been done in accordance with our national character, and never has that spirit of energy and industry which marks the Briton under every varying circumstance of time and distance, been more proudly exhibited than in the bold and ardent expedition with which the surface of his country was chequered by a net work of great commercial highways, constructed in almost every respect on principles the very antipodes of those which have guided other nations in their imitation of the same spirit. Seizing at once upon the experimental fact, that the friction of iron wheels upon iron roads is incomparably smaller than upon roads of stone, and connecting this with the no less certain truth, that resistance to motion is made up of friction and gravity, the English engineer conceived the grand idea of almost annihilating gravity by reducing the track of the railway to nearly a perfect level. It was demonstrable that the same absolute power which could impel a given weight on a common road at 10 miles an hour, would, on a level railway, impel five times that weight at treble the velocity, and it was further unquestionable that an inclination greater than 1 in 224 would at least double the power required to effect this, and thus diminish the superiority of the railway by one half. If a horizontal railway be compared with a horizontal common road, the superiority of the former over the latter is as 15 to 1; but if a railway inclining 1 in 30 be compared with a common road also inclining 1 in 30, its superiority in this case is only as $1\frac{1}{2}$ to 1. Following out the principle of which these are illustrations, it is no less obvious now than it was in the origin of railways, that the more nearly the planes of a railway approach to a level, the more superiority will they present over the common road. It was this principle which demanded in the name alike of science and of commerce, that in the track of the railway every mountain should be brought low, and every valley should be filled up; it was this which caused the transport of vast masses of earth from the higher to the lower parts of the country, which forced the deep excavation, reared the lofty embankment, bored the yawning tunnel, and dealt with all the most solid materials of earth, as if they had been the playthings of a baby's doll-house, instead of fabrics which require to be encountered by the sinews of hosts and the wealth of nations.

For, acting on principles which appeared to be sanctioned by every maxim of wisdom and experience, who can blame, with any show of reason, the engineers of this country, to whom the world is so much indebted, no less in the early origin, than during the steady progress of railway engineering. Fifteen years ago, when railway science was in its infancy, no voice was raised in opposition to the principle of almost horizontal gradients, and the necessity for those gigantic works which this principle demanded was as heartily acquiesced in by directors, by shareholders, and by the whole public, as by the engineers themselves. Nay, had it been otherwise—had the engineers stood alone in support of their principle—had the public voice been against them—and had the public press branded their projects as extravagant and wasteful, we are amongst the number of those who contend that they would still have done right to maintain their principle, and we should have applauded and admired them the more for carrying, in the first instance, a superior degree of excellence into those works which were destined to furnish an example to the whole civilized world. We confidently appeal to any competent judge, who, thoroughly understanding the mechanical and political distinctions between the railway and the common road, shall fairly and dispassionately review the circumstances of this country, whether we should have done well or wisely to adopt a less horizontal succession of planes for those main lines which are probably destined to endure for ages, as the great arteries through which commerce will ramify into a thousand inferior channels all over the face of the country. While we thus regard with great satisfaction the superior character with respect to gradients which has been adopted for all the great railways of this country, there is yet another element in their construction, which, while it influences in no degree whatever the facilities for locomotion, yet contrasts remarkably in point of expense with corresponding works on the American lines. We shall readily be understood here as referring to those costly bridges and viaducts of iron, brick and stone, which have so enormously swelled the estimates for executing our principal railways. To decide upon the kind of gradients to be adopted for a given line of railway—a decision which regulates, more than any thing else, the cost of its construction—required, in the first instance, only a knowledge of simple principles, and in the absence of that experience which later years have supplied with respect to the comparative expense of working lines with steep and with level gradients, our engineers acted in a spirit of perfectly sound wisdom, when they laid the greatest practicable tax upon capital for the purpose of enabling the nation to realize, in its full extent, the superior advantages of railway transit. But in deciding on the style and character of the attendant works, which are entirely independent of the surface of the railway, the question assumes a purely commercial aspect, and may be thus stated: Suppose a line of railway with the most complete and substantial works of masonry, to have cost, say, one million of money, and suppose the same line could have been constructed with a more perishable class of works, as for instance, bridges and viaducts of timber, at an expense of half this sum, which kind of work is it most judicious to adopt, having regard to the circumstance, that after the lapse of a certain number of years the constructions of timber will require to be renewed, whilst those of masonry would require only very trifling repairs. Suppose in the former case, where the railway had cost a million sterling, the interest derived from the expended capital would amount to 5 per cent per annum. It is clear that in the latter case, where the line only cost half a million, the interest derivable on the capital would be 10 per cent. Now supposing 5 per cent of this to be set aside as a reserved fund, would the works of timber last so long a time as not to require restoration, until the reserved fund had sufficiently accumulated to effect this restoration? This is the grand point which should decide between the adoption of timber, or a more expensive and durable material for the architectural works of railways. We are not here to be understood, for one moment, as contending that any such proportion, as that which has been assumed, exists between the cost of a railway with stone bridges and viaducts and one in which their works are of wood. What we have said, however, will be sufficient to indicate the general principle of the comparison, and the utmost concession we are prepared at present to make to the champions of cheap and therefore temporary railways, is this, that the comparative cost and the comparative durability of the two classes of works are, in all cases, worthy of being considered by the engineer in connexion with the estimated amount of revenue derivable from any given line.

We are aware that, in all this, we are stating nothing new to the engineer; nothing but what has already occurred to most of the leading members in the profession, and nothing but what will be extensively practised, in laying out the numerous branch railways, which the convenience of the country still requires. Our object in making these observations, will be amply fulfilled, if they succeed, in disabusing some part of the public mind, of the notion, that the costly stations and bridges and viaducts are all that distinguish our railways from those of Europe and of America. It should be remembered, that the much larger capital expended on our works has effected a system of levels, which enables us to command far higher speeds, and to realize, in every way, greater advantages from the railway, as compared with the common road. In every case where it is desired to take a comprehensive view of railways, as a political question, it is essential to distinguish between that part of the cost which is due to the superior character of the buildings connected with the railway, and that which is incurred in conformity with principles immediately connected with the facilities for working locomotive power. On the former of these points, we grant, that a statesman, a merchant, or a financier of any kind, may form a competent judgment, with proper data before him. On the latter, the only qualified judge is the engineer, because a decision must in most cases be made with reference to the future, and particularly with reference to the future auspices of engineering and mechanical skill. Thus, in the origin of railways, the engineer alone was qualified to chalk out a system of gradients which should correspond with the known properties of the locomotive engine, and of iron as a material for the wheels of carriages to roll upon—so in like manner Mr. Brunel, or those of like qualifications, are alone entitled to consideration in deciding such a question as that of the gauge to be adopted for the Great Western Railway, because the accuracy of the decision depended upon the truth or error of certain prognostications in physical science, which a mere financier, however able, is not competent to entertain. The engineer, in fact, must regulate his operations, both by past experience and by anticipations of the future; to what extent these latter are or should be based upon, the former depends on many circumstances, but to some important extent, all will admit, that the past should influence our future projects of every kind. It would, therefore, be highly desirable at the present time, that accurate and comprehensive returns should be framed of the actual working cost of locomotive power on all railways of every different rate of inclination, in order that a correct judgment may be formed upon the influence which gradients really exert in affecting the working expenses of railways. Thus would information of great value be placed at the engineer's command; but until sufficient data have been obtained to clear this subject of the obscurity which now rests upon it, we certainly must protest against the blind and wholesale jumbling which has been perpetrated by some who profess to be authorities on the subject of railway estimates. We insist, most strongly, upon the necessity for separating the cost of attendant works from those which have been rendered essential purely by the character of the gradients adopted; and we warn all those, who, without any engineering knowledge to guide them, shall be rash enough to commit themselves to paper, on subjects of this nature, that the less they have to do with the engineering part of the subject the better. The attendant works, as we have said, involve more or less of commercial considerations, and these should therefore be free for discussion; and anything possessing novelty and merit, which can be placed before the engineer in the way of designs, applicable to such attendant works, will no doubt be received by the profession at large with interest and gratification.

The spirited publisher of the work before us, is already too well known, and too highly valued by the profession to require anything from us in the way of general praise. If any such testimony were wanting, it will always be gratifying to acknowledge the many valuable contributions to engineering science, which Mr. Weale has originated, and which he has been something more than a secondary means of giving to the world. In the production entitled Railway Ensamples, however, Mr. Weale appears before us in a new character. He has here assumed the province of authorship, and in this capacity places himself before the bar of public opinion, subject to that judgment, whether of condemnation or approval, which that severe tribunal hesitates not to pronounce, on all who thus prominently court her notice. In some respects, we feel bound to congratulate Mr. Weale upon the character he has here assumed—we hail with pleasure, on a first view, the modest and simple announcement of the titlepage, and assuming the value of his examples, as specimens of design, we are glad to perceive that an individual has had the spirit and sagacity to present to the notice of the English engineer a connected series of works from a foreign railway. On looking further into their examples, we find them to be drawn from the Utica and Syracuse Railway, an American line about 53 miles in length. Whether these examples be worthy or not of presentation, in such a form, to the engineers of this country, is not now the question; supposing they are so, the profession is undoubtedly much indebted to the individual who has thus incurred the pains and expense of bringing them before their notice. Mr. Weale's appearance in the character of an author, however, is not limited to the dry and brief notices which are required to illustrate a set of railway plates, but embraces a somewhat extensive catalogue of subjects connected with railway engineering which have been condensed into 40 pages of preliminary observations. These observations are accompanied by several maps, and by plates of an American locomotive engine, and an American earth excavator. Although we cannot agree with the writer in many of these preliminary observations, we have at the same time great pleasure in stating, that the reader will find amongst them much that is interesting and amusing. We may mention particularly the description of the American locomotives, and that of the Satellite engine on the London and Brighton Railway. We are not able to say much in praise of the excavating machine; it appears to be a very clumsy affair, encumbered by a mass of machinery out of all proportion to the effect required. Its economy is extremely doubtful except when put in competition with very high prices for labour, in which case it might possibly be more economical than manual labour for excavating earth. The machine is said to be capable of excavating 1500 cubic yards in 12 hours, at a cost for fuel of 12*s*. per diem. To this statement, Mr. Weale adds, that "earthwork in England has generally been taken at 10*d*. to 1*s*. per yard." He forgets, however, that this price includes the carriage or haulage of the earth, and that the price of getting and filling the stuff, which is all that the American machine performs, is commonly not more than from 2*d*. to 5*d*. per yard. It is, therefore, some mean between these two prices which should be taken for comparison with the machine; but at present, we are not able to make this comparison, having no information as to her cost and working expenses.

A second division of the preliminary observations is principally directed to a comparison between the cost of the American railways and those of this country. The principal facts on which Mr. Weale argues, are these, that the aggregate cost of the American railways was estimated in 1839, at £4000 per mile, including all buildings and apparatus; and secondly, that actual works are not executed cheaper in America than in this country, as the greater expense of timber here is counterbalanced by the greater expense of labour there. He therefore, concludes that the greatly increased cost of the English railways has been caused by the more expensive nature of the works, that is by the difference of the two systems of construction. This is undoubtedly true to a certain extent, and here the comparison might cease, with this observation, that we have obtained far superior railways, by expending more money in their construction than the Americans. In case, however, any erroneous notions may be formed as to the comparative eligibility of the two systems, which are here contrasted, it may be sufficient to suggest, that no *fair* comparison can be made without full particulars, not only of the works executed on each, but also of the gradients and curves with which the lines were respectively constructed. It will be found that gradients of 25 to 30 ft. per mile are considered highly favourable in America, whereas, those of greater steepness than 15 or 16 feet per mile, have been held in this country to be highly objectionable. Again, as to curves, the American lines abound with sharp bends, which are quite inadmissible in those of Great Britain. A large proportion of the American lines are graded only for single lines of way; and in many of those which are graded for double lines, only a single track has been laid down. The cost per mile, as stated above, furnishes a very unfair comparison, in every respect, with the English lines, where the gradients and curves are entirely of a different order, the works are far more substantial, are mostly constructed for a double line of way, and where the cost of land has necessarily been excessive; whereas, in America the land in many cases has cost almost nothing. Another important point of comparison is the annual expense of working the railways in the two countries. M. De Gerstner estimated, in 1839, that the annual expense of working the American lines was 63·61 per cent. of the gross income, and that the interest on the whole capital invested in railroads in the United States does not exceed 5½ per cent. per annum. Now this annual expense is far greater than that of working the English railways—as, for instance, the Grand Junction costs 55·53 of the income, the Great Western 51·87 per cent.; and taking the average of all the railways, it would be found considerably below the American lines. In the case of the English lines, this amount will be still further reduced when their heavy earth works become perfectly settled, and no longer subject to those slips which, up to this time, have occasioned such heavy expenses. We find that the average dividend of 32 railways reported in the *Railway Times* amounts to 4*l.* 10*s.* per cent. per annum, which, although less in absolute amount than that produced by the American lines, is in reality far greater when the prospective circumstances are considered. Thus, for instance, supposing the slight timber bridges and viaducts of the American lines will last 20 years, which is a favourable supposition, where is the capital to come from in order to effect their restoration at the end of that time. Undoubtedly it can scarcely be reserved out of the present dividends of 5½ per cent., for nearly the whole amount will be required to provide the large capital for restoring their perishable works. On the other hand, the English lines, firmly and substantially constructed, are paying a steady dividend of 4½ per cent. on the average and no reserved fund is required, as the works are calculated to endure for many centuries. The conclusion to be drawn from all this is highly unfavourable to the American system, and at the same time encouraging to those who have embarked their capital in our own lines. While the railways of the United States must inevitably, in a very few years, present a condition of premature decay, with a hopeless prospect of restitution, those of this country will, in all probability, afford a more favourable investment for capital than at the present day. We have no wish to dispute much that is really valuable and ingenious in the railways of the United States, but we must contend against these lines being held up as a model for the great trunk lines of this country. Mr. Weale points out several lines in which he considers the American system would be applicable, and particularly advocates its adoption in Ireland. With certain restrictions, and under certain circumstances connected with the expected revenue, and the capital available to the undertakings, the American system of cheap *temporary* constructions and inferior gradients may be advisable for some lines in Ireland, but we should extremely regret to see the main lines in that country laid out on such a principle.

The most valuable part of Mr. Weale's book, because the most practical, and that which contains the most information is that which relates to the bridges actually constructed for the American railways.

The Utica and Syracuse Railroad, which has been selected as affording so favourable a specimen of cheap engineering in the United States, forms part of the great line of communication across the states of Massachusets and New York. This great line, which has been executed by several different companies, is upwards of 530 miles in length. It commences at Boston, in Massachusets, and passing through or near the towns of Worcester, West Stockbridge, Albany, Schenectady, Utica, Rome, Syracuse, Auburn, Waterloo, and Worcester, sweeps along the southern shore of Lake Ontario, for the last 200 miles of its course, from the Atlantic Ocean, and terminates at Buffalo, the north-eastern extremity of Lake Erie. The part of this great line which lies between Utica and Syracuse, is 53 miles in length, and throughout its course it follows the line of the Erie Canal. We have no information as to the gradients on this line, but judge that that they must be extremely favourable, as the Erie Canal was on a perfectly dead level, without any canal lock whatever between Utica and Syracuse, and for several miles east of the former place.

After an attentive examination of the plates referring to these bridges, we feel bound to pronounce that, as specimens of carpentry, they possess by no means superior merit. In place of that admirable system of timbers abutting against each other, which gives so much stiffness to some of the best specimens of English carpentry, the light planks of the American bridges are held together by an innumerable quantity of bolts, and the proper strength of the timber is not applied to the fullest advantage. The white pine, which is used so extensively in the American bridges is a timber very little known in this country. It is a white wood with a short grain, possessing little strength of fibre, and abounding in small black knots; it is used a good deal in Edinburgh and other parts of Scotland for the interior of houses, but is never applied to external work.

In addition to the plates of the bridges, and of the viaduct over a considerable valley and creek on this railway, there are several plates, showing the system of piling and laying the permanent way on a part of the line about 19 miles in length which was laid upon piles, the remaining length being graded, as it is called in America, that is formed by cuttings and embankments, as usual in this country.

There are also several plates showing culverts, but these possess little interest for the English reader; nor could the engineer derive any advantage from a comparison of this part of the American railway system with his own. The last portion of the work contains an interesting account (historical and statistical) of the Belgian railways by Mr. Edward Dobson, but we believe this part of the work is only a translation.

These ensamples of railway making, affording the best account which has yet been published in this country of the railroad works of the United States, will certainly find a place in the library of every engineer. Although we cannot consent to the wholesale adoption of the American system which Mr. Weale appears to advocate, there are yet many cases, both here and on the continent, in which these examples will prove very useful in railway engineering. We must not omit to mention, in conclusion, that the plates, as in all Mr. Weale's works, are admirably executed, and the details are so well shown that the most ordinary capacity may readily comprehend every part of the construction.

The Principles and Practice of Land, Engineering, Trigonometrical Subterraneous, and Marine Surveying. By Charles Bourns, C. E. London: John Ollivier.

We need scarcely say that on all occasions we feel much greater pleasure in speaking well of any book which comes under our notice than when we are obliged to pronounce an opinion of almost unqualified censure. In the present instance, however, an impartial reviewer has only the latter alternative; and we could wish sincerely for the credit of the profession both at home and abroad, that the production of works with such feeble claims upon public favour were much less rare than it is. We are told in the preface of Mr. Bourns' book, that the aim with which it is written has been "the formation of a book of reference." Had this really been the case, had the volume been merely a work of reference, and had it been so styled on its title-page, we should have known what to expect, and should never have been deceived into supposing that we were opening a book containing the principles and practice of every kind of surveying. But we are told in a few lines further on in the preface, "that the volume is intended to constitute a consistent whole; so that to understand an advanced part, a person must be conversant with what goes before." How then can it be a work of reference in the common acceptation of this term, since by the author's own showing, it requires a regular study to be made of what goes before, in order to understand any advanced part. Surely this destroys its value as a work of reference. Indiscriminate censure is seldom just, and in the present case we are far from saying that the book before us is absolutely worthless, and that there is nothing in it which might be instructive to the professional man. At the same time we feel bound to enter a strong protest against that too prevalent system of book-making of which this work is a remarkable specimen. It contains an immense mass of antiquated information injudiciously selected and badly arranged. The few grains of original matter which are scattered through its pages relate to minute points of professional practice, often magnified into undue importance, and introduced to the exclusion of more valuable things for no reason that we can discover, except that they happen to have formed part of the author's own practice, or to have been introduced by some of his friends. We make no pretence of having waded through the whole contents of this book, which is an octavo volume of 356 pages; but having looked into several of those parts of it which are not purely elementary, the general impression is by no means such as to encourage a further search. In every point of view the work is far inferior to those of Mr. Bruff, and to Mr. Williams' Geodesy, books which have been reviewed in former numbers of the *Journal.*

Blunt's Civil Engineer and Practical Mechanist. Division C. Portion the Second. London: Ackerman and Co.

This portion is principally devoted to the delineation and description of machinery by the Messrs. Rennie. The first plate is of the gun-boring and turning mill, with the lathe apparatus—machinery used in gun and engine manufacture. Another plate is of Messrs. Rennie's great boring lathe; it is used in the boring of cylinders, condensers, air pumps, and bored vessels of engines and mills, and in turning pistons, rods, shafts and journals. Three plates are of their marine dredging and excavating machine, part of which was in the first portion. The last plate is devoted to Sir Isambard Brunel's shield for the Thames Tunnel. We must observe, however that although we have used the term plate to express the several sheets, many parts of the works are separately described on each sheet, and form valuable drawings for reference.

Turning and Mechanical Manipulation, intended as a Work of General Reference and Practical Instruction, on the Lathe and the various Mechanical Pursuits followed by Amateurs. By CHARLES HOLTZAPFFEL, A. Inst. C. E.

MR. HOLTZAPFFEL looking at the dearth of works on the arts professed by the mechanical engineer, has felt himself called upon to bring before the public the results of his experience on a subject of so much interest and value. It is fortunate, perhaps, for the mechanical engineer, that turning and many other of his pursuits have for a long period formed a favourite occupation with many wealthy individuals, as thereby an amount of patronage has been conferred on the tool maker, such as could have been obtained by no other means, and which has powerfully conduced to the improvement of the tools used in this important department, while many experiments have been made at private expense, which could scarcely have been executed by persons engaged in business. With a class of wealthy amateurs to whom to look for supporters, Mr. Holtzapffel could scarcely have rendered a more acceptable service than the production of a work, which, both to the practical man and the amateur, must be of high utility. Mr. Holtzapffel, in the resources of his large establishment, and availing himself of the experience of his predecessors in the firm, possesses many advantages for the task he has undertaken, and seems to devote himself to it *con amore*. The treatment of it he proposes to enter into at some length, and we can scarcely blame him for this, as the public will profit by the extent of labour devoted to the subject.

The volume now before us is one of five, and is devoted to the consideration of the various materials used. The second will discuss the principles of construction and application of cutting tools; the third will treat of hand turning; the fourth of complex or ornamental turning, and the fifth of the principles and practice of amateur mechanical engineering.

The description of the materials is distributed into three classes; the vegetable, the animal, and the mineral kingdoms. The description of the various kinds of woods, not only developes new facts as to their technical peculiarities, but illustrates their botanical characteristics, a portion of the work to which Professor Royle has contributed his valuable assistance. The materials from the animal kingdom, which are treated with no less ability, include shells and mother of pearl, bones, horn, tortoiseshell, whalebone and ivory. The materials from the mineral kingdom, embrace clay, amber, jet, cannel coal, the ornamental and precious stones, the metals and their alloys. To state, however, that the work is limited to a simple description of these materials, would convey an inadequate idea of its value, as it abounds with practical descriptions of many important or interesting processes. Thus we have observations on seasoning, softening, bending, and colouring wood; the manufacture of iron; forging, hardening and tempering of iron and steel; the melting and mixing of metals; and the properties of alloys; casting and founding; wire drawing and soldering. To the description of tempering alone twenty-five pages are devoted, and the subject is treated with a minuteness and ability, which leave nothing to be desired.

The Atmospheric Railway. Observations on the Report of Sir F. Smith and Professor Barlow. By THOMAS F. BERGIN, M.R.I.A. Dublin: Hodges and Smith, 1843.

Considerable controversy has existed on this subject, and a long correspondence has taken place between Mr. Bergin and Professor Barlow; with respect to it, we, however, are more inclined to look forward to the result of the great trial now in progress at Dublin, than to depend upon any mathematical formula, upon the bases of which no party seems to be agreed. The experiment will soon be satisfactorily settled one way or other, and the merits or demerits of the atmospheric system, will be shown in all their extent. Mr. Bergin has devoted considerable ability to the discussion of the subject, and the many who saw reason to distrust Professor Barlow's deductions, cannot do better than consult this pamphlet.

A Series of Diagrams, Illustrative of the Principles of Mechanical Philosophy. Drawn on Stone, by HENRY CHAPMAN, and Printed in Colours, by C. F. Cheffins. London: Chapman and Hall.

The fourth and fifth parts illustrate the pulley, inclined plane and wedge. The plan, which is that of giving practical and useful applications of the simple powers is well carried out, and thus both theory and practice are at once brought to bear on the instruction of the student; while it is not only a good work for the machinist, but an excellent drawing book. The work contains so many illustration valuable machines, that we feel ourselves still more strongly called upon to urge the necessity of some letter-press explanations accompanying the plates, treating on the theory of the powers and their several applications.

The Literary and Scientific Pocket Book. By J. W. GUTCH. London: Lumley.

This contains much valuable matter of reference, and as such, we have much pleasure in recommending it to our readers.

ON THE STRENGTH OF BEAMS.

SIR—The problem proposed for solution by your correspondent "Concrete," at page 27 of the last month's *Journal*, is certainly one of great interest and importance; as he states, I believe, it has not been investigated in any of the standard works on the strength of materials. Like all questions connected with the strains of beams, it is one which, whether considered theoretically or practically, is of the most complicated nature and of great difficulty; particularly if investigated with mathematical accuracy. There are so many data to such questions, varying in each particular instance—so many circumstances which modify the general result—such as the deflection of the beam, and consequent variation of the length of leverage, the position of the neutral line, &c., that since the time of gables to the present day, they have always been considered as questions of the greatest difficulty; and yet there is no subject connected with theoretical mechanics more interesting to the engineer; none more useful, especially in the present age, when timber and iron are so extensively used in the most stupendous structures, the economy and durability of which depend so much upon the proper application of mechanical principles. I am sorry to say, however, that even now, there are many engineers, particularly those belonging to the old school, and such as have not the least knowledge of the elementary principles of mechanics, who will not admit its utility; who, because such men as Telford, Brindley, George Stephenson, and many others, have risen to eminence by the mere force of their talents, unfettered by, what they term, college knowledge, think that they may also jog on on the "thumb of rule" system. And yet, how frequently have I seen these pseudo-engineers, these practical men, who will not look into a book, for fear it should destroy the originality of their conceptions, fall into the greatest errors from the want of such knowledge. I shall merely state one instance. A resident engineer of one of our railways proposed a plan for strengthening a timber bridge on the line, and in order to test the efficiency of his improvement, made a model of the bridge on the scale, if I recollect rightly, of one inch to the foot; he found that the model would support a certain weight, and thence argued in a truly practical manner, that as the bridge was twelve times the model, it would support twelve times the weight! Thus satisfactorily establishing the utility of his proposed improvement. To return to the question to be solved. If we omit the consideration of the deflection of the beam, the result will be simple and sufficiently correct for practical purposes, and the problem in question may easily be reduced to that of finding the dimensions and form of a beam resting loosely on two supports, necessary to sustain a given weight, (in this instance 42 tons,) placed at the centre of the beam.

Your correspondent states that he found upon experiment, that a bar iron, loaded, as he describes, broke near the two supports; this certainly is strange, and contrary to what we should expect theoretically and practically; for it is evident that the beam between the two supports is more curved at the centre than near the supports, and consequently the strain, being measured by the tension of the fibres, must be greatest in the centre, and gradually diminish to the point of support. I have several times repeated his experiment on a small scale, using, however, wood instead of iron, and have always found that the wood broke in the centre between the supports; of course with the same proportion of external and internal parts mentioned by your correspondent.

It is also clear, from the principle of the lever, that the strain at the centre of the beam, is the same as that produced by a weight of 42 tons placed there, except that the action is reversed: the upper side of the beam will now be compressed in place of being extended, and the under side extended instead of being compressed. If what I have advanced be correct, as I believe, it will result that the best form to give to the beam is the parabolic; that is, the depth of the beam should be greatest at the middle point and diminish at the ordinates of a parabola towards the supports. As the reasons for assuming this form to be the best, are given in all works on the strength of materials, it would be useless to repeat them here. It is generally considered best to have the curved side of the beam upwards in such a case, but as in this example the action is reversed, it follows that it would be advisable to have the curved side downwards. As your correspondent only states the proportion of the distances of the weights from the points of supports to that between them, it is impossible to give the exact dimensions. I have not thought it necessary to give a diagram, as I believe, this explanation may be easily understood from the description, and by referring to that given by your correspondent.

If no better attempt to solve this problem be offered, you will oblige me by inserting this letter.

I remain Sir,
Your obedient servant,

London, Jan. 10th, 1843. T. F.

PROCEEDINGS OF SCIENTIFIC SOCIETIES.

ROYAL INSTITUTE OF BRITISH ARCHITECTS.

Dec. 19.—J. Shaw, Esq., in the Chair.

Mr. Fowler, Hon. Sec., on presenting a plan for rebuilding that portion of Hamburgh, lately destroyed by fire, from M. Chateauneuf, mentioned as a gratifying circumstance, that our countryman, Mr. Lindley, the engineer, had been appointed by the senate to superintend, in part, the rebuilding of the city.

Mr. Godwin read a paper on Tournay Cathedral, which was partly given in last month's *Journal*, and the continuation in the present number.

Jan. 9.—Charles Barry, Esq., V. P., in the Chair.

A paper was read "*On a new mode of constructing the Flues of Chimneys,*" by Mr. Moon, surveyor, explaining an improvement in the construction of flues, of a circular form, of different sizes, from 8 to 14 inches in diameter; the bricks are arranged in courses, carried up and bonded in the thickness of the wall.

"*Description of the Testimonial to the late Sir Harry Burrard Neale,*" erected at Lymington, communicated by Mr. Draper, of Chichester, the architect. It consists of an obelisk, 76 feet high, constructed of Dartmoor granite, standing on a pedestal 18 feet high, the total cost is about £1,400.

Mr. Sylvester's process was described "*for rendering stone, brick, and other absorbent materials impervious to water.*" It consists of two solutions, the first a solution of soap, the second of alum; the brick or stone is first dipped in the solution of soap, and afterwards in the alum, or the solution may be applied with a brush. By the combination of the two solutions, a chemical action takes place, which fills the pores and resists the action of water and moisture. Colouring matter may be introduced into the solutions, and give them any tint that may be desired.

Mr. Billings introduced his "*Illustrations of a mode of striking Gothic tracery;*" they were principally selected from the old choir of Carlisle Cathedral, which was repaired in 1764. The principle upon which most of the varieties of the tracery in this cathedral were formed, was by the combination of curves all having their centres in the same series of lines, formed by dividing a square into four parts each way. The interstices were afterwards filled up by quatrefoil and trefoil ornament, but the main curves are all formed on the above principle. Mr. Billings introduced a fine specimen of tracery, described by circles struck from every intersection of the lines within the square as centres.

Jan. 23.—T. L. Donaldson, Esq., in the Chair.

A letter was read from Herr F. Eisenlohr, Professor, acknowledging the honour of being elected an honorary and corresponding member of the Institute; this letter contains some excellent remarks which we have been permitted to extract.

"I shall esteem it," says Herr Eisenlohr, "a great honour to be united in closer intimacy with your Institute, by the communication of anything relating to the profession. Such an intercourse and reciprocity among the architects of different countries is much to be wished for at the present time, which is principally distinguished from all previous epochs in the history of architecture by its want of unity. Attempts have been made for some time past to remedy this by imitations of the ancient Greek and Roman styles of architecture; and up to the present day many architects are repeating with various talent and success, the attempt to introduce those styles into the present edifices—some, even the imperfect conception of them, called by the French *la Renaissance.* On the other hand, in many places in Germany, a different course has been adopted, which, being partly suggested by the revival of a more christian spirit, partly by the patriotic feeling excited by the French revolution, leaned more to the christian architecture of the middle ages at home. This two principal divisions, each with their varities, stand opposed to one another here in Germany, and carry on, as it were, a contest in secret. The present age is engaged in seeking a something which at present does not exist, viz., unity in a sort of universal architecture. It seems to me, that no immediate and direct imitation in any style of architecture already existing, complete in itself, will lead to the desired result as long as the present age demands its rights, and the existing state of society requires something arising more from its own nature. When I consider also that hitherto in our art we have acted in a manner too little abstractive and scientific, and have *imitated* too much, still, on the other hand, it is not to be denied that we cannot and ought not to disregard history and its effects, that we must have some point in history at which to begin a root, from which a new stem may shoot up into blossom as from the soil of the present. It is quite clear that here also theory and history must go hand in hand, whereby we must with *consciousness* attain to that new and unprejudiced position which, in childlike innocence, unconsciously existed at the commencement of all previous epochs in art. The difference between our age and its problem, as regards architecture, and indeed every branch of the arts, consists in this that we ought to strive, so to say, with manly innocence, with manly knowledge and power, to attain to that point at which former periods in art have in their infancy begun of their own accord. Where there is nothing but an empty and groundless adherence to forms, where architectural fallacy and pretension, or a certain coquetterie is manifested, there an art of a peculiarly creative nature can never be looked for. It is true that many grand buildings have recently been erected in the Roman, Grecian, and so called Byzantine and Gothic styles, as, for instance, particularly at Munich. But they all want the enlivening principle of belonging to the present, and are only silent records of bygone styles of architecture. In the same way that we collect pictures of different schools in galleries, so King Louis has collected buildings of all possible periods; and as he had not got them at Munich, neither could he transport them thence from other parts; he had them built, and thus made a grand collection of buildings at Munich, but which is still deficient in historical authority. If, therefore, we would draw a comparison, we must say that the modern collection of buildings at Munich is, as far as regards the arts, worth about as much as a picture gallery containing a number of more or less successful copies from different masters and schools. If it be true that the spirit of the times is truly expressed in its buildings, that the architecture of every period is, as it were, a fossilized history, future generations will say that the present period was utterly devoid of character. By means of a more intimate acquaintance with the history of architecture, we have been provided with a vast quantity of subject matter, which has hitherto quite overwhelmed us, from its variety and quantity, so that we were quite robbed of our senses. Of this we must first get the mastery, and impelled by a careful observance, as well as by an artistical and inventive spirit, regain our consciousness, without at the same time suffering the experience of history to remain useless. We must, on the one hand, investigate from a theoretical and scientific position, how far our architecture and its elements answer to the conditions of its purpose, of the building materials, climates, and so forth; and must, on the other hand, in looking back upon history, endeavour to find some point which presents constructions and forms similar to those which result from our abstract investigations, and thus a fruitful germ may be found for a modern and, in itself, harmonious style of architecture—a style which would gradually come into general use, and supersede all the lifeless imitations and mere whimsical charges of fashion. In this, it appears to me, consists the great architectural problem of the present age, which can only be solved by united efforts."

Report *on the Marbles from Lycia.*

A report was read from the committee appointed by the Institute to examine the articles that were recently discovered by Mr. Charles Fellowes amongst the ruins of Xanthus, an ancient city in Lycia, in Asia Minor, and lately deposited in the British Museum. Mr. Fellowes explained to the committee "that the tomb is situated on the side, on the slope of a hill, in the old town of Xanthus, consisted of a square shaft in one block, weighing about 80 tons, and 17 feet high. This shaft, which rested on a base or plinth rising six feet from the ground on one side, and the other rising but little above the present level of the earth, was surmounted by the bas-relief in question, the opposite sides of the relief being respectively 8 feet 4½ inches, and 7 feet 6 inches long making a total length of 31 feet 9 inches. It consisted of four angular and four central blocks of marble, each 9 inches thick and 3 feet 5 inches high. A kind of chamber was soon formed in the top of the monument about 7 feet 6 inches high, and 7 feet by 6. This was covered by a single block of marble forming the cornice, and hollowed out in the inside soffit so as to present the appearance of a beam and caissons. Mr. Fellowes considers the subject of the sculptures to represent the legend of the daughters of King Pandarus carried away by the harpies. There are also five figures, male and female, seated on chairs, which are evidently intended to be represented as made of bronze; on these chairs are very perceptible traces of a brownish tint approaching to red, showing that the ornament was indicated by colour, even without the outline being carved.

The figures are about an inch and a half in relief, and in many parts there are patches of blue colour on the ground, particularly on the undercutting of the hair, and especially where the recesses are protected by the overhanging tenia of the frieze, forming the top of the blocks. A portion of this blue colour had been taken off by Mr. Hawkins, and submitted to a chemical analysis by Dr. Faraday, who reported that "The substance is a mixture of wax with a pulverized blue smalt, coloured by cobalt, the smalt being in rather coarse patches; when the wax is charred away, each piece is seen by a moderate magnifier as a small fragment of glass."

On referring to the analysis of Egyptian blue colour by Dr. Ure, given in the 3rd vol., pp. 301—3 of Sir T. Gardiner Wilkinson's work on the manners and customs of the ancient Egyptians, there appears to be a great analogy in the composition of this blue and that described by Sir J. Wilkinson; as in the Egyptian specimen the blue pigment scraped from the stone is a pulverulent blue glass.

On the edge of the crest of a helmet were also collected some remains of a bright crimson red which have not yet been analyzed.

On the whole, the committee are of opinion that the appearances which they witnessed are sufficient to warrant their conclusion, that the ground throughout was painted blue, so as to give relief to the figures. Some other parts also had colour, but to what extent the rough state of the surface of the marbles did not enable the committee to ascertain.

The character of the sculpture of the figures denotes a very remote period of art, and it is, to a certain degree, rude; but the forms and embellishments of the bronze chairs are extremely refined, and betoken a class of art not unlike that of the triple temple in the Acropolis of Athens.

When the other marbles and fragments brought from Xanthus have been removed into the upper halls of the Museum, the committee will proceed with their examination on this interesting subject, and they will, if necessary, report to the Institute the result of their inquiries.

The Chairman, in consequence of the unavoidable absence of Mr. Britton, who was to have read a paper this evening, was requested by the secretaries to supply a paper, which he readily acceded to with his usual promptness in all similar difficulties; the subject of the paper was "*On the ruins of the city of Ani, in Armenia*," but as we are likely to give the paperin full next month, we defer giving any abstract.

The meetings for February will take place on Monday 6th, and 20th, at 8 o'clock.

INSTITUTION OF CIVIL ENGINEERS.

Jan. 10.—JAMES WALKER, Esq., President, in the chair.

This was the first meeting of the session, and was occupied by a discussion on a paper by Mr. Davison, describing the sinking of the deep well at Messrs. Truman and Co.'s, brewery, which was read at the close of last session. See *Journal*, Vol. 5, 1842, page 420.

Jan. 17.—The PRESIDENT in the Chair.

This was the annual general meeting of the Society, and was occupied in reading the report of the council, the election of the council and the distribution of the prizes; we must defer until next month a report of the proceedings when we hope to be able to give them in full.

DESTRUCTION OF THE ROUND-DOWN-CLIFF BY GUNPOWDER.

[We are partly indebted for the accompanying report to the *Times*, and through the kindness of two professional friends, who were on the spot and witnessed the explosion, we have been enabled to give considerable additional information; and have also added a rough sketch of the cliff, that was hastily taken, just before and after the explosion took place.]

DOVER, JAN. 26TH, 1843.

You will not be surprised to hear that the announcement that an explosion of 18,000 lb. of powder was to be made in the Round Down Cliff this afternoon brought an influx of strangers into this town; still, though considerable, it was not so large as I had expected. Curiosity was, I think, paralyzed by a vague fear of danger, which kept some thousands at home who might have witnessed it, as the event turned out, without the slightest shock to their nervous system. The experiment succeeded to admiration, and, as a specimen of engineering skill, confers the highest credit on Mr. Cubitt, who planned, and on his colleagues who assisted, in carrying it into execution.

Everybody has heard of the Shakspeare Cliff, and I have no doubt that a majority of your readers have seen it. I should feel it a superfluous task to speak of its vast height were not the next cliff to it, on the west, somewhat higher. That cliff is Round Down Cliff. the scene and subject of this day's operations. It rises to the height of 375 feet above high-water mark, and was, till this afternoon, of a singularly bold and picturesque character. To understand the reasons why it was resolved to remove yesterday no inconsiderable portion of it from the rugged base on which it has defied the winds and waves of centuries, I must make your readers acquainted with the intended line of railway between Folkestone and this place.

At Folkestone there will be a viaduct of great height and length. Then there will be a tunnel, called from a martello tower near it, the Tower Tunnel, one third of a mile in length. Then comes a cutting through the chalk of two miles in length, called Warren's Cutting. Then comes the Abbott's Cliff tunnel, one mile and a quarter in length, and now half finished, although only commenced on the 16th of August last. From the Abbott's Cliff tunnel to the Shakespeare Cliff tunnel the railroad will be under the cliffs close to the sea, and protected from it by a strong wall of concrete two miles long, and with a parapet of such a height as will not preclude passengers from the splendid marine view which lies under them. Now it was found that when a straight line was drawn from the eastern mouth of the Abbott's Cliff tunnel to the western mouth of the Shakespeare tunnel, there was a projection on the Round Down Cliff which must be removed in some way or other to insure a direct passage. That projection, seen from the sea, had the appearance of a convex arc of a circle of considerable diameter. It is now removed, and some idea of its size may be formed from the fact that a square yard of chalk weighs two tons, and that it was intended by this day's experiment to remove 1,000,000 tons. The Shakspeare tunnel is three-quarters of a mile long, and it is about the same distance from that tunnel to the town of Dover.

Having premised thus much as to the locality of Round Down Cliff, I now proceed to describe, as briefly as I can, the means employed to detach from it such an immense mass of solid matter. A horizontal gallery T, Fig. 3, extended for about 100 yards parallel with the intended line of railway, from which cross galleries were driven from the centre and extremes. At the end of these cross galleries shafts were sunk, and at the bottom of each shaft was formed a chamber, 11 feet long, 5 feet high, and 4 feet 6 inches wide. In the eastern chamber were deposited 5000 lb. of gunpowder, in the western chamber 6000 lb., and in the centre chamber 7000 lb., making in the whole 18,000 lb. The gunpowder was in bags, placed in boxes. Loose powder was sprinkled over the bags, of which the mouths were opened, and the bursting charges were in the centre of the main charges. The distance of the charges from the face of the cliff was 70 feet at the centre and about 55 feet at each end. It was calculated that the powder, before it could find a vent, *must* move 100,000 yards of chalk, or 200,000 tons. It was also confidently expected that it *would* move 1,000,000 tons.

The following preparations were made to ignite this enormous quantity of powder;—At the back of the cliff a wooden shed was constructed, in which three electric batteries were erected. Each battery consisted of 18 Daniels' cylinders, and two common batteries of 20 plates each, to which were attached wires which communicated at the end of the charge by means of a very fine wire of platina, which the electric fluid as it passed over it, made red-hot, to fire the powder. The wires covered with yarn were spread upon the grass to the top of the cliff, and then falling over it were carried to the eastern, the centre, and the western chamber. Lieutenant Hutchinson, of the Royal Engineers, had the command of the three batteries, and it was arranged that when he fired the centre, Mr. Hodges and Mr. Wright should simultaneously fire the eastern and the western batteries, to ensure which they had practised at them for several previous days. The wires were each 1,000 feet in length, and it was ascertained by experiment that the electric fluid will fire powder at a distance of 2,300 feet of wire. After the chambers were filled with powder, the galleries and passages were all *tamped* up with dry sand, as is usually the case in all blasting operations.

At 9 o'clock in the morning a red flag was hoisted directly over the spot selected for the explosion. The wires were then tested by the galvanometer, the batteries were charged, and every arrangement was completed for firing them.

It was arranged that the explosion should take place at 2 o'clock; at that time there was an immense concourse of people assembled. In a marquee erected near the scene of operation, for the accommodation of the directors and distinguished visitants, we observed among the number assembled, Sir John Herschell, General Pasley, Col. Rice Jones, Mr. Rice, M.P., Professors Sedgwick and Airy, the Rev. Dr. Cope, and there was also a strong muster of engineers, among whom were Mr. Tierney Clark, Mr. John Braithwaite, Mr. Charles May, Mr. Lewis Cubitt, and Mr. Frederick Braithwaite; the engineers and directors of the Greenwich, Croydon, Brighton, and South Eastern Railways, besides numerous foreigners of eminence.

At 10 minutes past 2, Mr. Cubitt, the company's engineer in chief, ordered the signal flag at the western marquee to be hoisted, and that was followed by the hoisting of all the signal flags. A quarter of an hour soon passed in deep anxiety. A number of maroons, in what appeared to be a keg, was rolled over the cliff, and on its explosion with a loud report, all the flags were hauled down. Four more minutes passed away, and all the flags except that on the point to be blasted were again hoisted. The next minute was one of silent, and breathless, and impatient expectation. Not a word was uttered, except by one lady: who, when too late, wished to be at a greater distance. *Galeatum sero duelli pœnitet.* Exactly at 26 minutes past 2 o'clock a slight twitch or shock of the ground was felt, and then a low, faint, indistinct, indescribable moaning subterranean rumble was heard, and immediately afterwards the bottom of the cliff began to belly out, and then almost simultaneously about 500 feet in breadth, with reference to the railway's length of the summit began gradually to sink.

There was no roaring explosion, no bursting out of fire, no violent and crashing splitting of rocks, and what was considered extraordinary, no smoke whatever; for a proceeding of mighty and irrepressible force, it had little or nothing of the appearance of force. The rock seemed as if it had exchanged its solid for a fluid nature, for it glided like a stream into the sea, which was at a distance of about 100 yards—perhaps more—from its base, tearing up the beach in its course, and forcing up and driving the muddy substratum together with some debris of a former fall, violently into the sea, and when the mass had finally reached its resting place a dark brown colour was seen on different parts of it, which had not been carried off the land; the shattered fragments of the cliff are said to occupy an area of 15 acres, but we should judge it to be much less. I forgot to minute the time occupied by the descent, but I calculate that it was about four or five minutes. The first exclamations which burst from every lip was—"Splendid, beantiful!" the next were isolated cheers, followed up by three times three general cheers from the spectators, and then by one cheer more. These were caught up by the groups on the surrounding downs, and, as I am informed, by the passengers in the steam boats. All were excited—all were delighted at the success of the experiment, and congratulation upon congratulation flowed in upon Mr. Cubitt for the magnificent manner in which he had carried his project into execution.

As a proof of the easy, graceful, and swimming style with which Round Down Cliff, under the gentle force and irresistible influence of Plutus and Pluto combined, curtseyed down to meet the reluctant embraces of astonished Neptune, I need only mention that the flagstaff, which was standing on the summit of the cliff before the explosion took place, descended uninjured with the fallen debris.

No fossil remains of the slightest importance were brought to light, which was a matter of disappointment to many. A very few even of the most ordinary character were found among the mass, which it may well be imagined was soon after the explosion, teeming with the curious multitude from the cliffs above anxious to obtain some relic of the event.

On examining the position occupied by the debris of the overthrown cliff, we were much pleased to find it more favourably disposed than we could have conceived possible. Instead of occupying the site of the proposed railway at the foot of the cliff, it had by its acquired velocity slid past it, and left comparatively little indeed to be removed. At some considerable distance from the cliff, the fragments appeared to be heaved up into a ridge, higher than any other part, forming a small valley towards the cliff, and another seaward, beyond which a second ridge appeared, when it finally slopes off towards the sea. The chalk was by no means hard, and appeared thoroughly saturated with water. The great bulk of the fragments ranged from about 2 to perhaps 8 or ten cubic feet, although we observed a vast number of blocks, which contained from two to three cubic yards and upwards, one of which was driven some distance into the Shakespeare Tunnel, without doing injury to the brickwork. There was very little, indeed, of what might be termed rubbish in the mass.

Previous to the explosion, we had heard it stated that about a million yards were expected to be detached; indeed the Railway Times so stated it, on the 21st ultimo, apparently from authority, and after the explosi n took place, it was publicly asserted by one of the officials, that three quarters of a million of cubic yards had come down. Now, on cubing the stated dimensions of the mass, which were given as under 300 feet in height by, say 50 feet longer than the gallery, which would therefore be 350 feet, by an average thickness or depth from the face of the cliff of 60, we shall have 233,333 cubic yards; but as the present face slope of the cliff is greater than before, the average thickness perhaps might be increased to 75 feet, which would make the quantity 291,666 cubic yards, from this is to be deducted 50,000 yards, the estimated quantity to be now shifted in forming the road, we shall then have 30,000 yards effectively removed by the expenditure of one ton of powder. We understand that Mr. Cubitt, the engineer, afterwards stated that a saving of six months' work, and £7000 expenditure was effected by this blast. Now allowing 6*d*. per yard for the removal of the quantity now required to be shifted, which would amount to £1250, and £500 for the powder used in the blast, the cost of forming the galleries, tamping, &c. &c., we shall find that this mass has been removed at a cost of 1.44 pence per yard. Again, taking Mr. Cubitt's statement, that a saving has been effected of £7000, to which, if we add the £1750, expenditure by the present plan, we shall find that he estimated the cost of removal by hand labour, at rather less than $7\frac{1}{4}$*d*. per yard.

We felt an interest in examining the beds and fissures of the chalk in the neighbourhood of this blast, which clearly indicated that the plan of removal adopted by Mr. Cubitt, was not only the cheapest, but the safest method which could have been adopted. The vertical fissures which here traverse the chalk appear to lie pretty nearly parallel, and at a slope perhaps of one-fifth to one-tenth to one. It was in one of these fissures that the whole mass parted and slipped down, on which we believe it had set previously, no doubt brought about by the infiltration of water more than the sapping of the base by the sea. So treacherous indeed was this chalk, that if we are rightly informed, a mass equal nearly in bulk to that blasted on Thursday came down unexpectedly some time since in the night time, burying in its ruins a watchman or foreman belonging to that part of the line. In the zigzig gangways cut along the face of the cliff, to enable persons to ascend to the summit—this sliding of the chalk where those vertical fissures are intersected, appears very frequently, inspiring the passer-by with a feeling of great insecurity. How far the water might be intercepted, or otherwise be prevented from filtering through these fissures is a question of great importance, and would not, we think, be one of difficult remedy. It also becomes a matter of interesting inquiry as to the effect which a lesser qantity of powder would have had, deposited and fired in the same manner. Would it only have made the mass insecure, or caused a partial sliding down, rendering it then more difficult of removal by hand than at first? The proportion of powder which Mr. Cubitt employs in his blasting operations we understand is determined thus: "The cube of the line of least resistance in feet, gives the quantity in half ounces;" but in this case there does not appear to have been any such quantity employed, though much more than heretofore is found necessary in usual blasting operations. Perhaps the most curious circumstance, connected with the operation, was the apparent absence of shock on the firing of the charge on some spots in the immediate vicinity, while at other, far more distant, it was clearly perceptible. Thus where the batteries were placed, those in charge of them thought the charge had missed fire, from their being insensible to any shock, while at five times the distance along the face of the cliff, it was clearly felt. But even along the face of the cliff it was very evident that the shock was felt by some and not by others, though standing within a few yards of each other.]

Fig. 1.—Section of the Cliff.

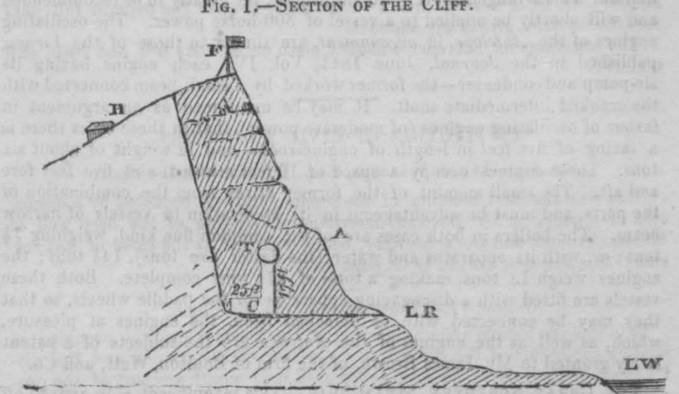


Fig. 2.—Section showing the movement of the mass.

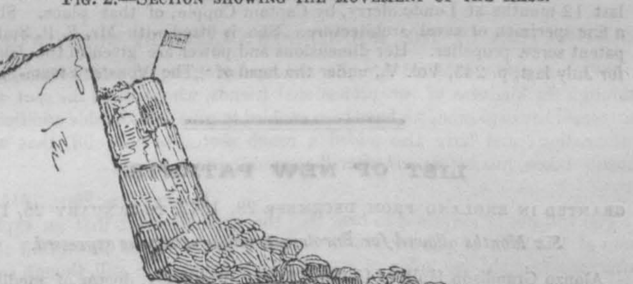
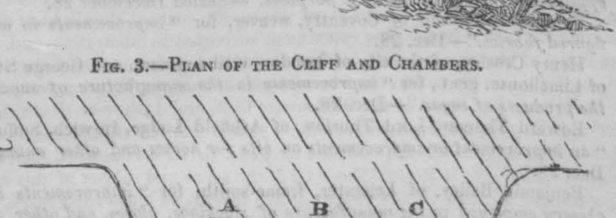


Fig. 3.—Plan of the Cliff and Chambers.



Reference.

Fig. 1.—Section of Cliff before the explosion; H house in which the batteries were placed, F flag over the spot, T tunnel or heading, C one of the chambers, L R level of proposed railway, L W level of low water.

Fig. 2.—Section showing the movement of the mass.

Fig. 3.—Plan showing the projection of the cliff; the heading T, and chambers A in which 50 barrels of gunpowder were placed, B 70 barrels, and C 60 barrels.

Neapolitan Steamers.—We lately had the pleasure of attending the trial of two steam vessels, named the *Rondine* (Swallow), and the *Antelope*, built at Northfleet, by Mr. Pitcher, for the revenue service of his Neapolitan majesty. The engines of both vessels are manufactured by Messrs. Boulton, Watt, and Co. These vessels are of similar dimensions, in fact built from the same drawing, and are in length between perpendiculars, 100 feet; keel for tonnage, 90 feet, 5 inches; extreme breadth, 16 feet; moulded breadth, 15 feet 5 inches; depth in hold, 9 feet 6 inches; tonnage, O.M., $123\frac{11}{94}$; displacement as launched, 65 tons; ditto, complete with 23 tons of coals, 145 tons. Draft] at this, 7 feet 3 inches. Immersed section, 91 feet. Speed at measured mile = 9 miles per hour. Although the *Rondine* and *Antelope* are of the same capacity, they differ in the construction of their motive powers: the former, the *Rondine*, having beam engines, the *Antelope*, oscillating or vibrating cylinder engines, both of the power of 40 horses. Cylinders 26¾ in, diameter, stroke, 2.6, and 34 strokes per minute. The beam engines are of the usual construction, as designed by Boulton and Watt in 1818. The various parts are reduced in strength as experience and improved manufacture dictates; we perceive they have in this case abolished the headstock framing, substituting pillars and an entablature, secured longitudinally by strong deck or paddle beams, they are continued through the side, supporting the ends of the paddle shafts, so that they have no connexion with the spring-beam or frame of the paddle-boxes, thereby preventing tremulous motion. This arrangement is by no means new, yet greatly to be recommended and will shortly be applied to a vessel of 300 horse power. The oscillating engines of the *Antelope*, in *arrangment*, are similar to those of the *Virago*, published in the *Journal*, June 1841, Vol. IV., each engine having its air-pump and condenser—the former worked by a small beam connected with the cranked intermediate shaft. It may be mentioned as an argument in favour of oscillating engines (of moderate power), that in these cases there is a saving of five feet in length of engine-room, and in weight of about six tons. These engines occupy a space of 10 feet athwart, and five feet fore and aft. The small amount of the former arises from the combination of the parts, and must be advantageous in its application to vessels of narrow beam. The boilers in both cases are of the common flue kind, weighing 7½ tons; or, with its apparatus and water (the latter five tons), 14½ tons; the engines weigh 13 tons, making a total of 27½ tons complete. Both these vessels are fitted with a disengaging apparatus for the paddle wheels, so that they may be connected with, or detached from, the engines at pleasure, which, as well as the engines of the *Antelope* are the subjects of a patent lately granted to Mr. James Brown, of the firm of Boulton, Watt, and Co.

THE GREAT NORTHERN STEAM-SHIP.—This magnificent ship arrived off Blackwall at the beginning of last month, and has since taken up a berth in the East India Import Dock. The Great Northern has been built within the last 12 months at Londonderry, by Captain Coppin, of that place. She is a fine specimen of naval architecture. She is fitted with Mr. F. P. Smith's patent screw propeller. Her dimensions and power are given in the *Journal* for July last, p. 243, Vol. V., under the head of "The *Monster* Steam-Ship."

LIST OF NEW PATENTS.

GRANTED IN ENGLAND FROM DECEMBER 28, 1842, TO JANUARY 28, 1843.

Six Months allowed for Enrolment, unless otherwise expressed.

Alonzo Grandison Hull, of Clifford Street, Middlesex, doctor of medicine, for "*improvements in electrical apparatus for medical purposes, and in the application thereof to the same purposes.*"—Sealed December 28.

Thomas Thompson, of Coventry, weaver, for "*improvements in weaving figured fabrics.*"—Dec. 28.

Henry Crosley, of the city of London, civil engineer, and George Stevens, of Limehouse, gent., for "*improvements in the manufacture of sugar, and the products of sugar.*"—Dec. 28.

Edward Thomas, Lord Thurlow, of Ashfield Lodge, Ipswich, Suffolk, for "*an improvement or improvements on bits for horses and other animals.*"—Dec. 29.

Benjamin Bailey, of Leicester, frame-smith, for "*improvements in machinery employed in the manufacture of stockings, gloves, and other framework knitted fabrics.*"—Dec. 29.

John Stephen Bourlier, of Sherborn Street, Blandford Square, engineer, for "*improvements in machinery used in printing calicoes, silks, paper hangings, and other fabrics.*" (A communication.)—Dec. 29.

Joseph Rock, Jun., of Birmingham, factor, for "*improvements in the construction of locks,*"—Dec. 29.

Henry Samuel Rush, of Sloane Street, mechanic, for "*for improvements in apparatus for containing matches for obtaining instantaneous light.*"—Dec. 29.

Baron Victor de Wydroff, of old Bracknell, Berkshire, for "*improvements in the construction of railways and in wheels to run on railways, and in apparatus for clearing the rails.*"—Dec. 29.

John Bishop, of Poland Street, Westminster, jeweller, for "*improvements in apparatus for portioning steam power; and also improvements in plugs, cocks, or taps for steam gases and liquids.*"—Dec. 29.

Crawshay Bailey, of Nant-y-Glo iron works, Monmouth, Esq., for "*improved constructions of rails for tramways and railways.*"—Jan. 11.

James Harvey, Jun., of Regent Street, goldsmith, for "*improvements in steam engines.*" (A communication.)—Jan. 11.

William Ritter, of 106 Fenchurch Street, gentleman, for "*improvements in crystallizing and purifying sugar.*" (A communication.)—Jan. 11.

Julian Edward Disbrowe Rodgers, of Upper Ebury Street, chemist, for "*improvements in the separation of sulphur from various mineral substances.*"—Jan. 12.

William Jonn Loat, of Clapham, builder, for "*an improved mode of constructing floors and roofs.*"—Jan. 12.

Pierre Armande Comte de Fontain le moreau, of Skinner's Place, Sise Lane, for "*process or processes of combining clay with some other substances for the producing of a certain 'ceramic paste,' capable of being moulded into a variety of forms, and the application thereof to several purposes.*" (A communication.)—Jan. 14.

James Harvey, of Bazing Place, Waterloo Road, timber merchant, for *improvements in paving streets, roads, and other places.*" (Partly a communication.)—Jan. 14.

William Snell, of Northampton Square, gentleman, for "*improvements in machinery for the manufacture of farina.*"—Jan. 14.

Nathaniel Card, of Manchester, candle-wick manufacturer, for "*improvements in the manufacture of candlewicks, and in the machinery or apparatus for producing such manufacture.*"—Jan. 14.

Henry Hussey Vivian, of Singleton, Glamorgan, Esq., and William Gossage, of Birmingham, manufacturing chemist. for "*improvements in heating or reducing ores of zinc; also for improvements in furnaces to be used for reducing ores of zinc, part of which improvements are applicable to other furnaces.*"—Jan. 14.

James Hamer, of Wardour Street, engineer, for "*improvements in propelling vessels.*"—Jan. 19.

Thomas, Earl of Dundonald, of Regent's Park, for "*improvements in rotatory or revolving engines, and in apparatus connected with steam engines, and propelling vessels.*"—Jan. 19.

Joseph Kirkman, Jun., of Soho Square, pianoforte manufacturer, for "*improvements in the action of pianofortes.*"—Jan. 19.

Thomas William Bennett, of Gray's Inn Road, timber merchant, for "*improvements in paving or covering roads, streets, and other ways and surfaces.*"—Jan. 19.

Luke Hebert, of Dover, civil engineer, for "*improvements in machines for grinding, and for dressing or sifting grain, and other substances.*"—Jan. 19.

William Bates, of Leicester, fuller and dresser, for "*improvements in the dressing and getting up of hosiery goods, comprising shirts, drawers, stockings, socks, gloves, and other looped fabrics, made from merino, lambs' wool, worsted, cotton, and other yarns, and in machinery for raising the nap or pile in the same.*"—Jan. 6.

Thomas Sunderland, of Albany Street, Regent's Park, Esq., for "*improvements in moving floating bodies through water and air, and in accelerating the flow of water, air, and other fluids, through shafts, pipes, and other channels.*"—Jan. 19.

Uriah Clarke, of Leicester, dyer, for "*improvements in framework-knitting machinery, and a new kind of framework-knitted fabric.*"—Jan. 21.

Frederick Albert Winsor, of Lincoln's Inn Fields, barrister-at-law, for "*new apparatus for the production of light.*" (A communication.)—Jan. 26.

Charles Frederick Bielefeld, of Wellington Street, North Strand, papier-maché manufacturer, for "*improvements in suspending or hanging swing looking glasses and other articles requiring like movements.*"—Jan. 26.

William Palmer, of Sutton Street, Clerkenwell, manufacturer, for "*improvements in the manufacture of candles.*"—Jan. 26.

Henry Chapman, of Arundel Street, Strand, for "*a fabric for maps, charts, prints, drawings, and other purposes.*"—Jan. 26.

Frances M'Gretrick, of Ernest Street, St. Pancras, artisan, and Matthew Bailey Tennant, of Henry Street, Regent's Park, gentleman, for "*improvements in apparatus for preventing engines and carriages from going off railways, and for removing obstructions on railways.*"—Jan. 26.

Edward Smallwood, of North Lodge, Hampstead, gentleman, for "*improvements in covering roads, ways, and other surfaces.*"—Jan. 26.

Robert Goodacre, of Ullesthorpe, Leicester, gentleman, for "*improvements in weighing apparatus applicable to cranes or other elevating machines, whereby the weight of goods may be ascertained while in a state of suspension.*"—Jan. 26.

James Boydell, Jun., of Oak Farm Works, Dudley, Stafford, iron master, for "*improvements in the manufacture of metals for edge tools.*"—Jan. 26.

George Parker Bidder, of Great George Street, Westminster, civil engineer, for "*an improved mode of cutting that kind of slates, commonly called roofing slates, though sometimes used for other purposes.*"—Jan. 26.

William James Greenstreet, of Blackfriars' Road, gentleman, for "*improvements in machinery or apparatus for producing or obtaining motive power.*"—Jan. 26.

Joseph Kirby, of Banbury, Oxford, gentleman, for "*improved apparatus for manufacturing bricks, tiles, and other articles from clay or earthy materials.*"—Jan. 26.

George Phillips Bayly, of 146, Fenchurch Street, brush maker, for "*improvements in brushes.*"—Jan. 26.

Henry Phillips, of Exeter, chemist, for "*improvements in removing impurities from coal gas for the purposes of light.*"—Jan. 26.

Martyn John Roberts, of Brynycaeran, Carmarthen, Esq., for "*improvements in dyeing wool and woollen fabrics.*"—Jan. 26.

William Weild, of Manchester, Engineer, for "*improvements applicable to window blinds and curtains, part of which improvements are also applicable to doors.*"—Jan. 28.

David Isaac Wertheimber, of West Street, Finsbury Circus, gentleman, for "*improvements in calculating machines, part of which improvements is applicable to purposes where wheelwork is required.*"—Jan. 28.

John Barrow, of East Street, Manchester Square, engineer and smith, for "*improvements in the manufacture and hanging of window sashes.*"—Jan. 28.